PRODUCT ENGINEERING

VOLUME 7 NUMBER 11

MASON BRITTON, Vice-President

G. F. NORDENHOLT, Editor — K. H. CONDIT, Consulting Editor

F. A. FIRNHABER, Assistant Editor — JOSEPH KERR, Assistant Editor

PAUL WOOTON, Washington — W. E. KENNEDY, Manager

December Number

In this number will be found brief mention of some of the new plastics that have come on the market during the past year. December *Product Engineering* will have an article by C. H. Grill of General Plastics wherein he goes into detail about the new phenolic resins that have been developed to meet the requirements of new fields of application for these materials.

Rubber hose, especially since the availability of synthetic rubber to make it oil resistant, is now being used more extensively. Some styles can conduct fluids under pressures as high as thousands of pounds per square inch. Along with the development of such hose, it was necessary to design entirely new types of fittings and methods for attaching them to the hose. All of these developments will be recounted in an article "Rubber Hose for High Pressure Service" by A. D. Maclachlan, development engineer with the B. F. Goodrich Company.

Joining parts by furnace brazing has received a great deal of attention during the past few years. Developments in this method of joining parts have been going along at a steady rate. In December *Product Engineering*, Bruce W. Gonser will give a detailed explanation of furnace brazing and how the parts to be joined should be designed.

In addition, other feature articles and the usual departments.

Published monthly. Price 35c. a copy. Subscription rates — United States, Canada, Mexico, Central and South American countries $5 a year. All other countries $5 a year or 20 shillings. Entered as second-class matter August 21, 1936, at Post Office, Albany, N. Y., under act of March 3, 1879. Printed in U. S. A.

Branch Offices: 520 North Michigan Avenue, Chicago; 883 Mission Street, San Francisco; Aldwych House, Aldwych, London, W. C. 2; Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Atlanta, Ga.

CONTENTS FOR NOVEMBER 1936

ACTIVITIES AND TRENDS IN PRODUCT DESIGN 406
The results of a survey of engineering activity and the trends in the application of parts, materials and finishes.

NEW THINGS FOR IMPROVING PRODUCT DESIGN 422
Developments in metals and alloys, non-metallic materials, electrical and mechanical parts and finishes.

DEVELOPMENTS IN METALS AND ALLOYS 424
DEVELOPMENTS IN NON-METALLIC MATERIALS 429
NEW ELECTRIC MOTORS AND DEVICES 432
IMPROVED MECHANICAL PARTS 437
BETTER FINISHES AND PROTECTIONS 440

DIRECTORY OF SOURCES OF SUPPLY 9
Including materials, electrical and mechanical parts, finishes and engineering department supplies and equipment.

Contents Copyrighted, 1936, by McGraw-Hill Publishing Company, Inc.

McGRAW-HILL PUBLISHING COMPANY, INC.

***Publication Office*, 99-129 North Broadway, Albany, N. Y.**

***Editorial and Executive Offices*, 330 West 42d Street, New York, N. Y.**

JAMES H. McGRAW, JR., Chairman — MALCOLM MUIR, President — JAMES H. McGRAW, Honorary Chairman

MASON BRITTON, Vice-President — B. R. PUTNAM, Treasurer — D. C. McGRAW, Secretary

Cable address: MCGRAWHILL, New York, Member A.B.P. Member A.B.C.

How to get the most out of this practical reference-book issue

Let this number help you find new sales features for your 1937 models . . . . . follow this procedure

1 Check the trends in the use of specific parts, materials, finishes, and types of construction in the first section of the editorial content of this issue. These trends are shown in simplified charts and tables. They should help you to forecast the sales features which will be most popular on next year's models.

2 Read the second section for a condensed review of the latest developments in parts, materials, finishes and types of construction. Similar items are grouped together for your convenience in referring to them later. Each paragraph is numbered so that if you want further information on any item you may obtain it by writing to the editor and merely giving the paragraph number.

How to use the "WHERE-TO-BUY" Directory

3 This directory is separated into five sections: (1) materials, (2) electrical motors and parts, (3) mechanical parts, (4) finishes and (5) engineering department supplies and equipment.

Each section contains a list of the manufacturers and advertisements giving further information on the products covered.

After using the directory to find the list of the manufacturers of the product in question, refer to the advertisements of the companies listed in bold face type for further information on the product.

SAVE THIS ISSUE

Refer to it whenever you need new parts, materials, finishes, or drafting-room equipment . . . . it contains the only complete "Where-To-Buy" Directory made up especially for design engineers.

PRODUCT ENGINEERING

GEORGE F. NORDENHOLT, *Editor*

MCGRAW-HILL PUBLISHING CO., INC. NOVEMBER 1936 VOLUME SEVEN, NUMBER ELEVEN

Shall It Be Quality or Price?

TWO alternatives are offered to the product designer. He can either use all of his ingenuity to lower the cost and therefore the selling price of the finished product, or he can use the savings made by improved design to provide the customer with a better product at the same price. Which alternative he shall select depends largely on the type of product he is designing. If it is simple, utilitarian and relatively non-mechanical the chances are that the low selling price will be the principal appeal to the customer. But if the product is primarily a machine he will get farther if he works for improvement of quality and performance.

In a country like ours, where the standard of living is relatively high and steadily rising, people are seldom satisfied with things that are merely useful. They want to be sure to get the worth of their money and they demand durability and dependability, but they take pride in owning things that are up-to-date in design and appearance.

The dramatic demise of the Model T Ford marked the passing of the day of the utility automobile characterized solely by its low price and dependability. Two attempts have since been made to produce a utility car and both have ended in receiverships.

Our civilization has progressed because of the insatiable wants of men and women. Successful products are those that supply these wants at a price which the purchaser is able and willing to pay. Designing is therefore a matter of striking the right balance between improvement and cost reduction.

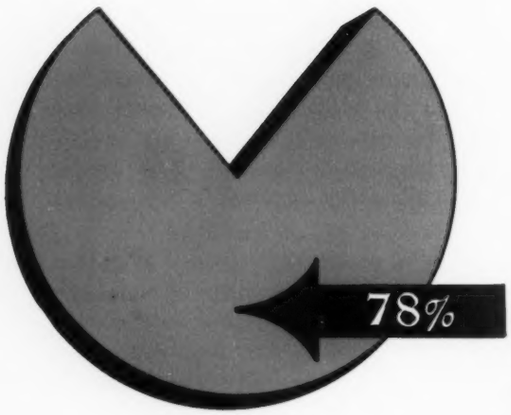
A good designer usually knows what refinements he should incorporate in his product but he is sometimes unable to find a way to do it at an economical cost. When he reaches that stage he is on dangerous ground because a competitor is almost sure to find the answer if he does not. Fundamentally the solution to this problem is always the same. The actual saving that makes possible the refinement desired may come from a change in process or a substitution of materials in some part of the product far removed from the particular unit under consideration. Sometimes the necessary saving may be accomplished through the single change but more often it is the accumulative effect of more than one alternative.

Designers who combine their own imaginations with ingenuity and a wide knowledge of available parts and materials which contribute to improvements and cost reduction in modern products are very rare indeed.

FOR the past five years, November *Product Engineering* has been devoted to a review of product design activity and a report of the extent to which various parts and materials are being adopted in the more important fields of design. This year there has been added a review of recent developments in parts and materials used by the product designer. By keeping abreast of trends and tendencies, and by becoming informed of the details of the new devices and materials which science is constantly developing, as is reviewed in this issue, the designer can do all that is humanly possible to keep his own product in the forefront of competition. The directory of parts and materials, also published for the first time in this number, has been prepared particularly to help the designer to accomplish his object.

Report of a survey covering 363 manufacturers of machinery and mechanical products to indicate the types of construction, unit parts, materials and finishes recently adopted, being used more extensively, or being considered for use

Activities and Trends in

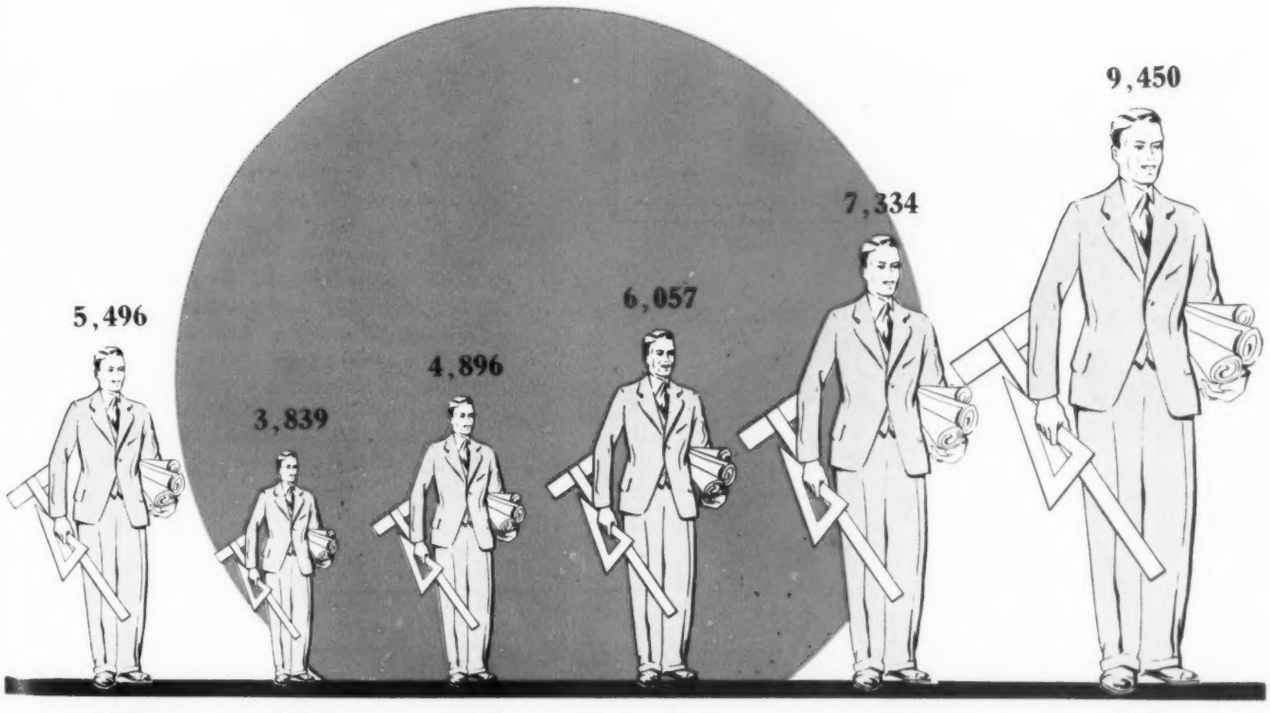


of the 315 companies that submitted figures on the number of engineers, draftsmen and research workers employed, reported bigger engineering staffs in 1936 than in 1935. Not since the depression has there been so much design activity

of the companies that have increased their engineering staffs over the past year expect to expand their engineering department still further during the coming year. These manufacturers are viewing the present activity as a fundamentally sound business growth

of the 363 manufacturers reported that during the past year they have developed new products or redesigned old ones. In many instances complete lines of products were redesigned and a few manufacturers developed entirely new products

Product Design



Since 1932 there has been a steady growth in the number of product designers, research workers, experimental engineers and draftsmen employed. This year 315 manufacturing companies reported an average increase of 29 per cent, the biggest increase in any year since 1932

Some of the Comments

"Suggest adding hydraulic couplings to your list." *Fans and Blowers.*

"Appearance is still of greatest sales importance. We continue to improve our finishes and are studying baked lacquers and resisting coatings. Also more styling." *Domestic Washers.*

"More durable finishes, safety devices and further standardization of parts will be our 1937 development aims." *Domestic Washers and Ironers.*

"Any interested in alloy castings for high-temperature service." *Gas and Oil Fired Water Heaters.*

"Use a great variety of alloys including stainless, bronze and electrical resistance wires." *Electric Ranges and Water Heaters.*

"More polished aluminum castings being used." *Domestic and Industrial Oil Burners.*

"We are using more pressed metal." *Domestic Electrical Appliances.*

"We are making increasing use of the services of industrial stylists." *Portable Air-Conditioners.*

"We are using more heat-treated steel and also more arc welding." *Fans and Blowers.*

Designers of Home Equipment Put

ADDITIONAL TRENDS

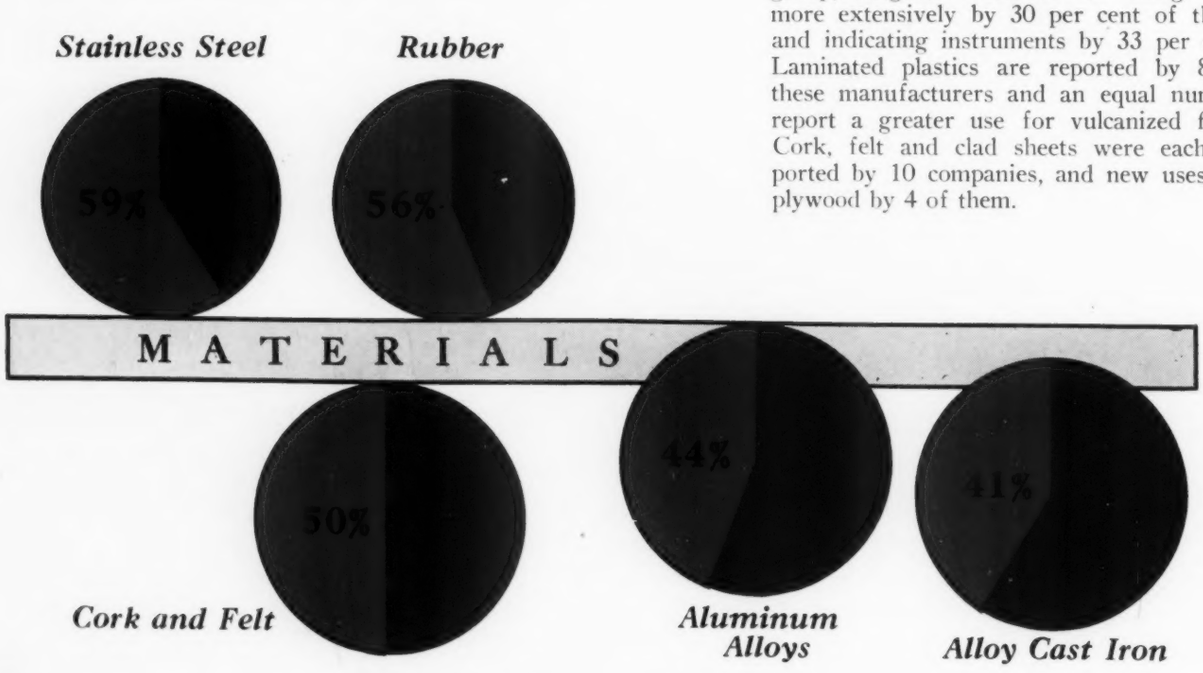
FOR the first time, fibrous glass appeared on our questionnaire and was reported as being adopted recently by 4 manufacturers in this group, and 11 more scattered among the other groups, all apparently for the purpose of heat insulation.

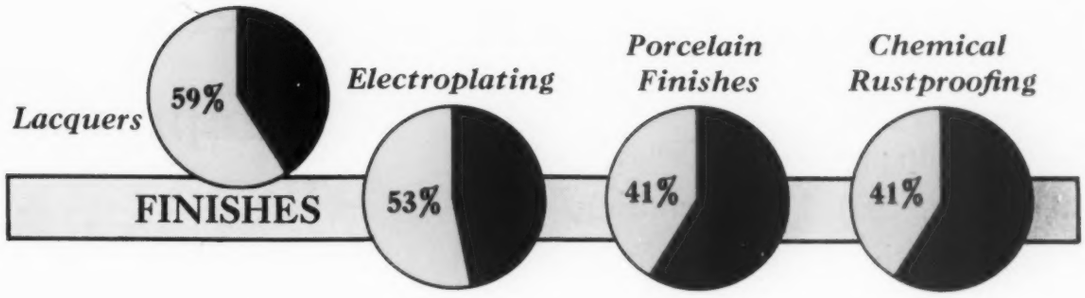
Out of 5 manufacturers of industrial refrigeration compressors and equipment all of them are using thermostatic devices more extensively, all but one reported a greater use of electrically-operated valves and 3 emphasized the use of resilient mountings.

Out of 10 manufacturers of domestic refrigerators, washing machines and ironers, all but one report a greater use of die-castings, 60 per cent are giving special attention to resilient motor mountings and half of them are using self-tapping screws.

Out of 10 manufacturers of portable air-conditioners, oil burners and stokers, 70 per cent report greater attention to and more extended use of sleeve bearings.

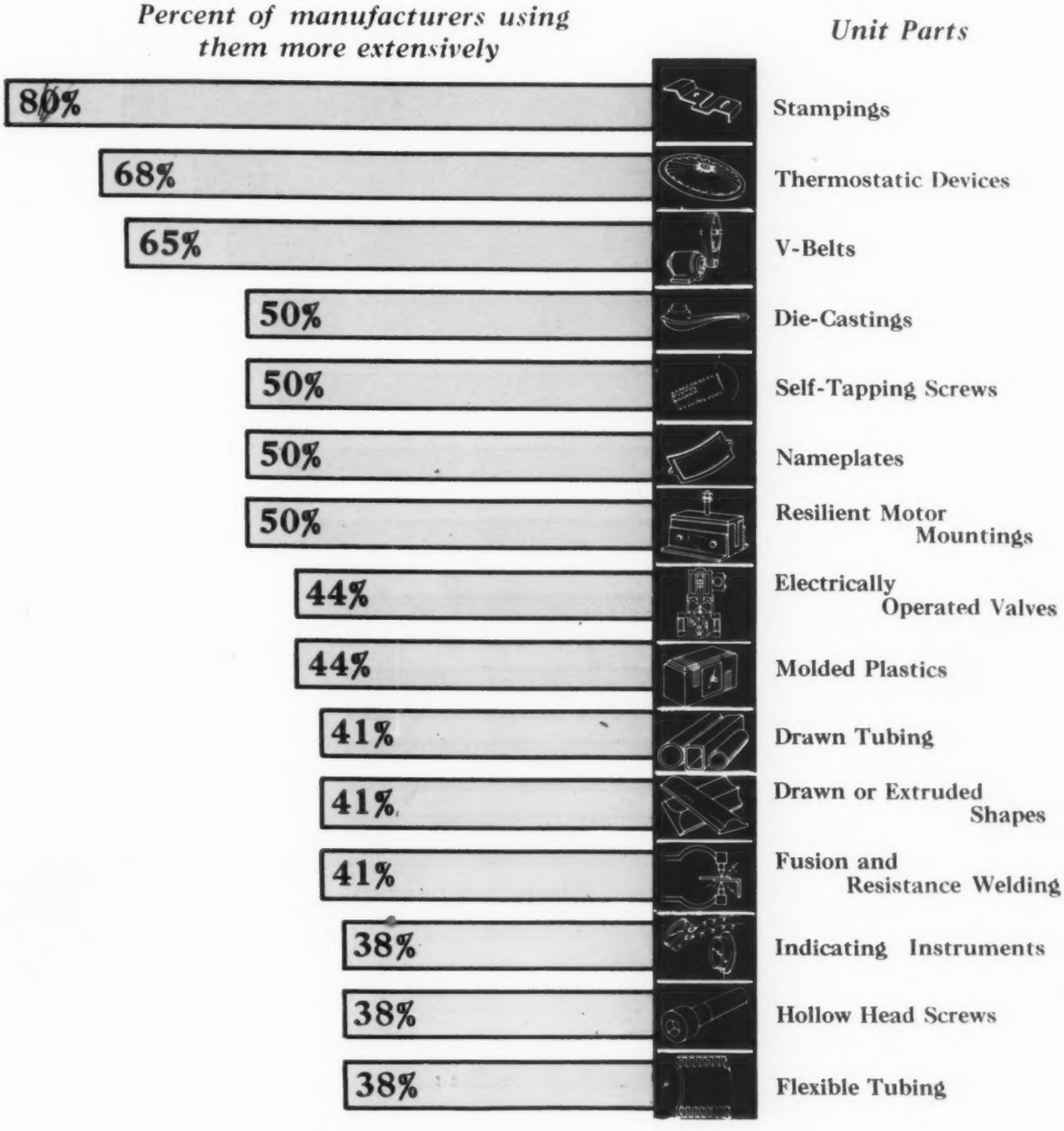
For the total of 34 manufacturers in this group, magnetic controls are being used more extensively by 30 per cent of them, and indicating instruments by 33 per cent. Laminated plastics are reported by 8 of these manufacturers and an equal number report a greater use for vulcanized fiber. Cork, felt and clad sheets were each reported by 10 companies, and new uses for plywood by 4 of them.





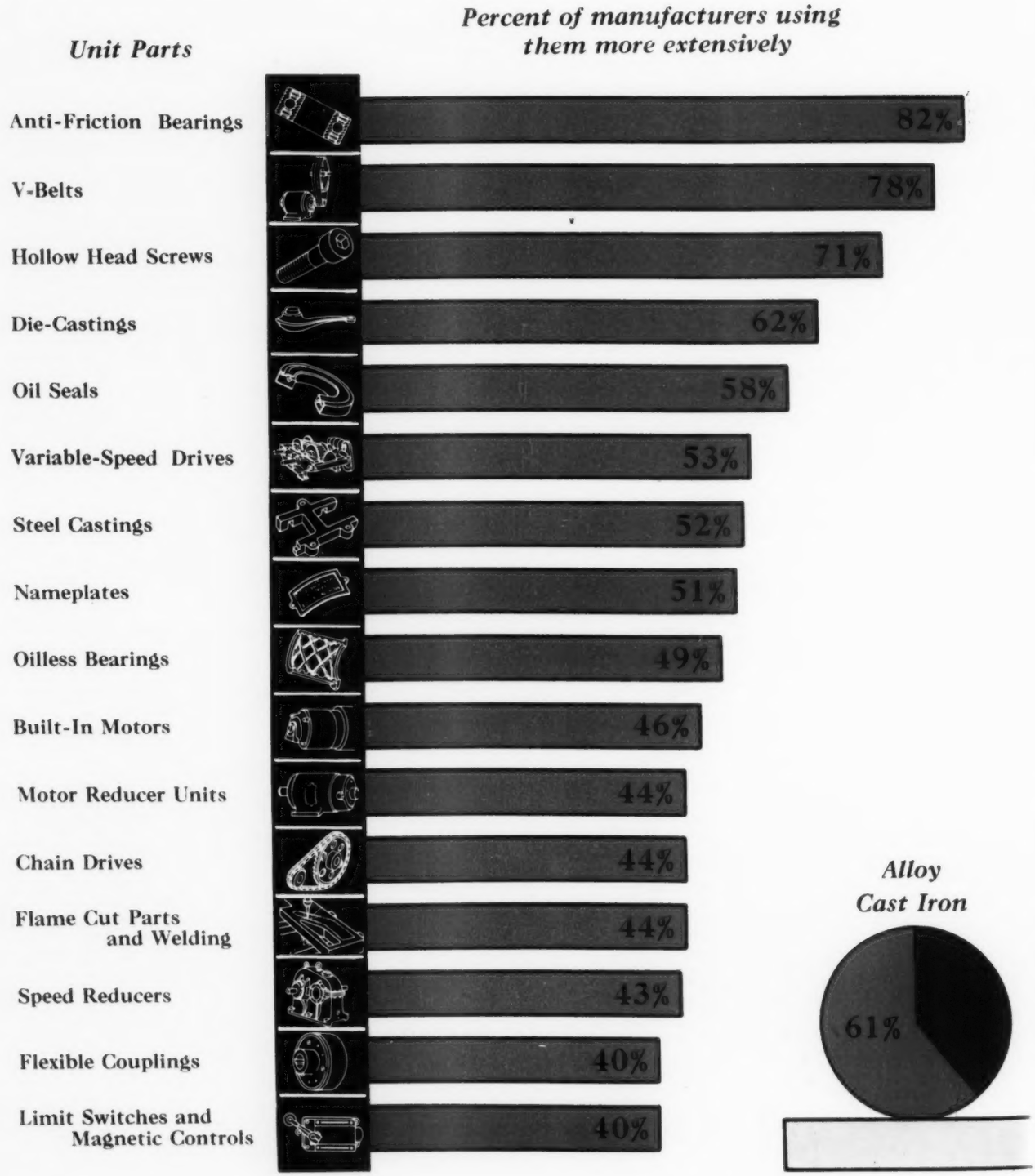
Emphasis on Appearance

In this group are included 34 manufacturers of refrigerators, oil burners, coal stokers, and domestic oil burning furnaces



Production Machinery Designers Improve Drives

In this group are 90 manufacturers of machine tools, textile, woodworking, paper making, printing and automatic machinery



and Speed Control

ADDITIONAL TRENDS

AMONG the marked trends is the increasing use of felt for various purposes. This was reported by 32 per cent of the manufacturers, whereas in the survey of 1935, this figure was less than 25 per cent. Low-alloy steels were reported by 30 per cent, and bronze by 39 per cent, and 22 per cent are equipping their machines with counters as a part of the original equipment.

Out of 39 machine tool manufacturers, 56 per cent are using more oil filters, 51 per cent are using magnetic controls more extensively and an equal number are making more use of hydraulic units.

Out of 17 manufacturers of textile machinery and equipment, the greater use of hollow head screws is reported by 75 per cent; oilless bearings by 70 per cent; drawn tubing 50 per cent; and felt 50 per cent.

Out of 8 manufacturers of printing machinery, 88 per cent are making more use of aluminum; 75 per cent are using more metal spraying and an equal number are using more chromium plating; and 50 per cent are going in for a greater use of central lubricators.

Out of 10 manufacturers of automatic packaging machinery, half of them are making more use of electronic controls, and all but one are applying variable-speed drives. All are using stainless steels more extensively, 4 of them also using it in the form of clad sheets. Six report more uses for aluminum alloys and 2 are extending the use of magnesium alloys.

Some of the Comments

"We are chromium plating many bars and bushings." *Machine Tools.*

"Using more metal spraying for surface protection." *Textile Machines.*

"Much of our large equipment is made up of welded members." *Printing Machinery.*

"Use much special drawn steel sections and extruded brass." *Printing Machinery.*

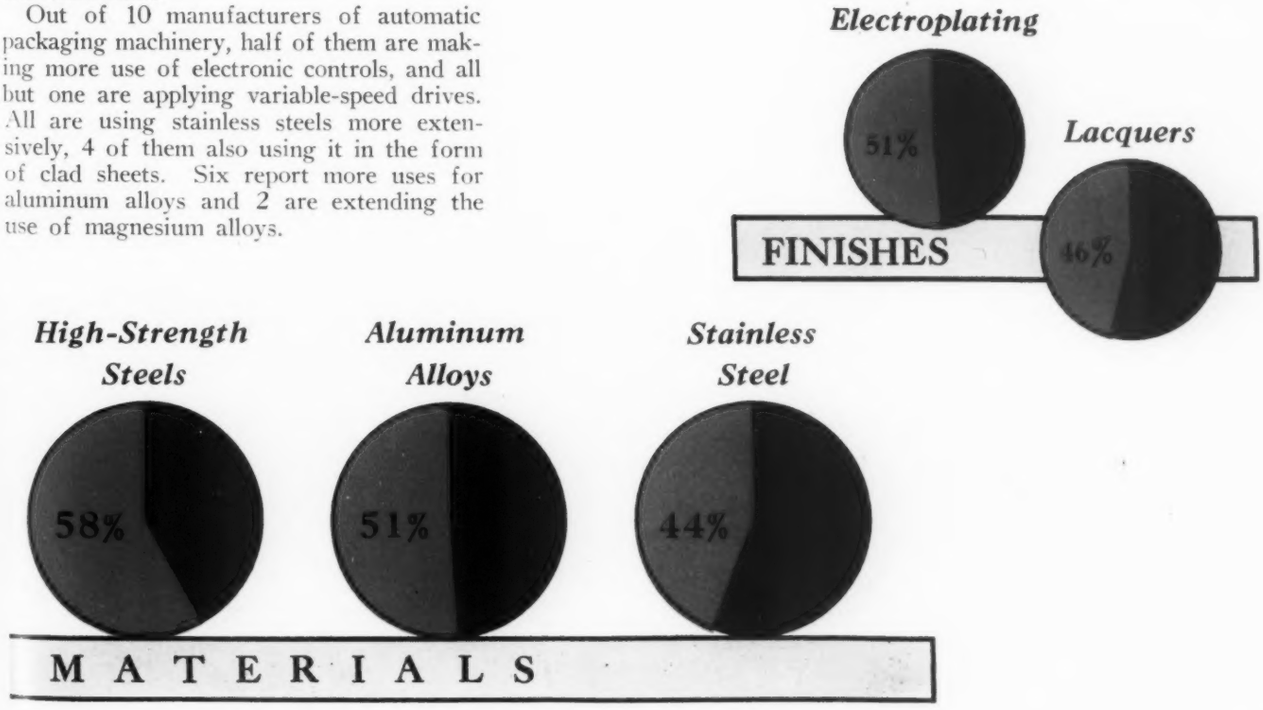
"We quote fabricated steel welded machine frames at approximately same cost as cast iron." *Printing Machinery.*

"We use Monel, stainless steel and nickel alloy castings in increasing quantities." *Dyeing and Bleaching Machinery.*

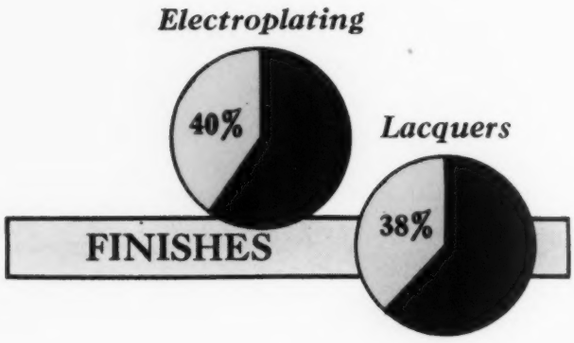
"Most of our machines are being redesigned to use roller bearing pillow blocks." *Printing Machinery.*

"We are interested in further possible applications of electrical and electronic controls." *Automatic Packaging Machinery.*

"Corrosion-resisting materials, including stainless steels and nonferrous alloys are being used in much greater volume." *Canning Machinery*



Plant Equipment Designers



ADDITIONAL TRENDS

OUT of 28 designers of air compressors and pumps, exactly half report a greater use of cork and rubber. Four designers noted on the questionnaire that they were using synthetic rubber.

The greater use of magnetic clutches, reported by 9 manufacturers, is featured by the diversity of the types of applications, these including air-conditioning units, foundry molding machines, rubber machinery, compressors and rolling mill equipment. Timers have been adopted by 14 of the manufacturers in this group and 23 are using more drawn shapes and tubing.

More drawn tubing is being used by 53 per cent of the 28 pump and compressor manufacturers.

Half of the 6 hydraulic press and equipment manufacturers reported the use of electronic controls and 5 of them are using electrically-operated valves. Two reported the adoption of built-in lighting.

Chain drives are receiving the attention of more than half the crane manufacturers, 78 per cent of whom are extending the use of oil seals. Five out of these 9 manufacturers are using drop forgings more extensively and 4 are using central lubricators more extensively.

Some of the Comments

"Class 1 fusion welding is coming into greater use." ***Boiler Manufacturers.***

"We are in need of, and developing, a better abrasion-resisting material." ***Foundry Equipment.***

"Welding is the most important manufacturing process today." ***Cranes and Presses.***

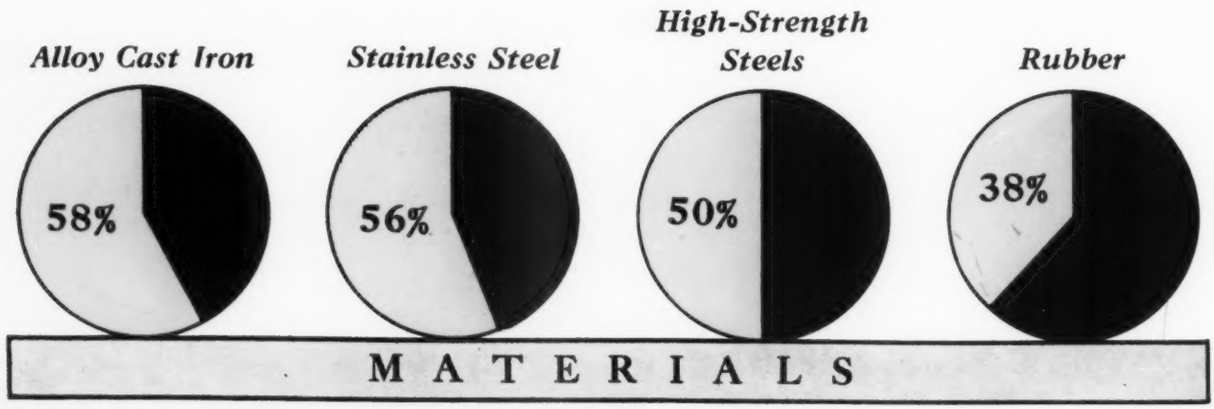
"We are adding more automatic controls and automatic speed changers." ***Electric Cranes and Hoists.***

"Particular trend is to alloy steels, copper-nickel alloys and alloy cast irons. We are still looking for a 'perfect' finish to resist corrosive waters." ***Deep-Well Pumps.***

"We are using synthetic rubber for the first time." ***Centrifugal Pumps.***

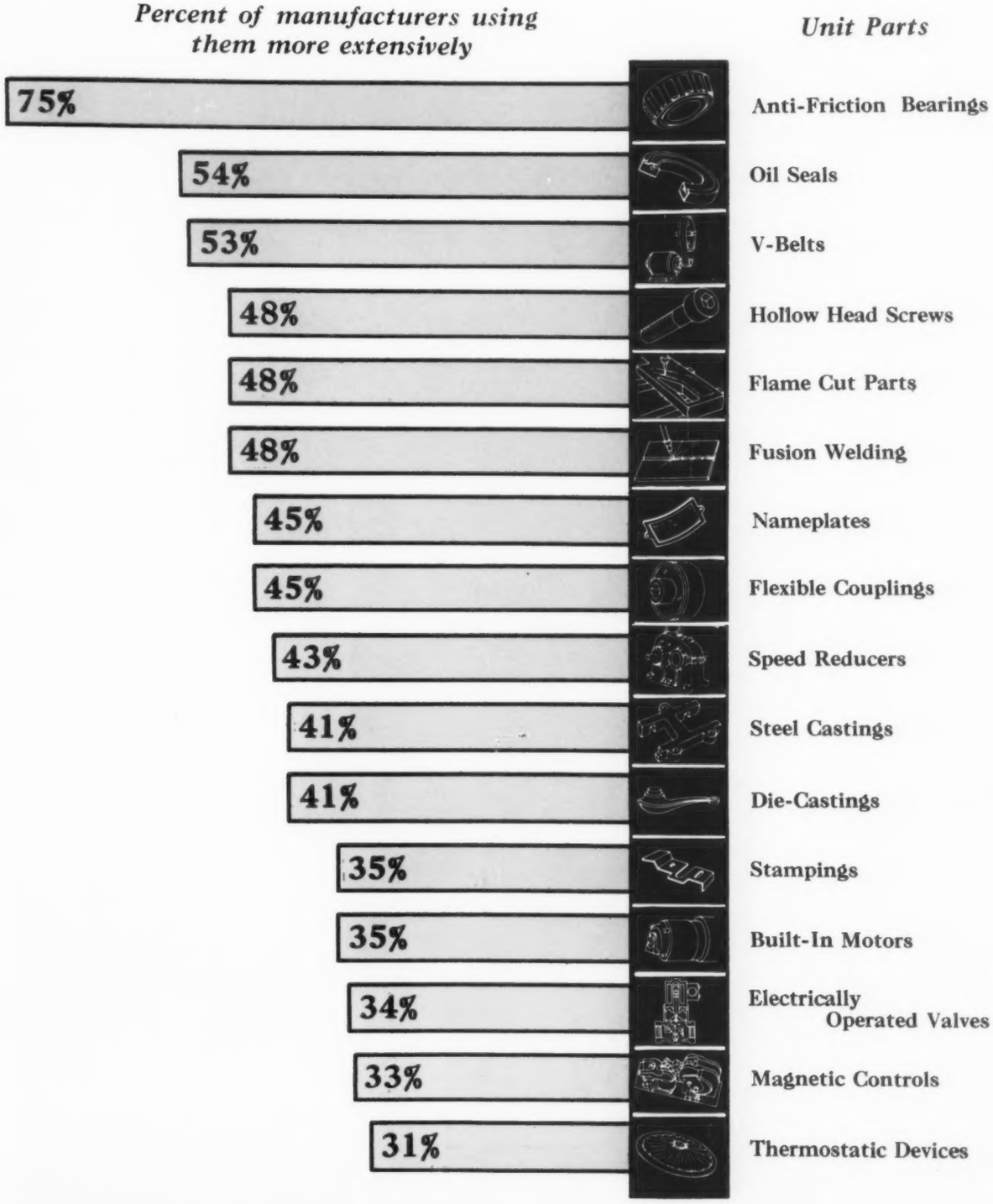
"Stainless and alloy steels of many varieties are being increasingly used." ***Steam and Centrifugal Pumps.***

"Considering using die-castings to a greater extent." ***Domestic Turbine Pumps.***



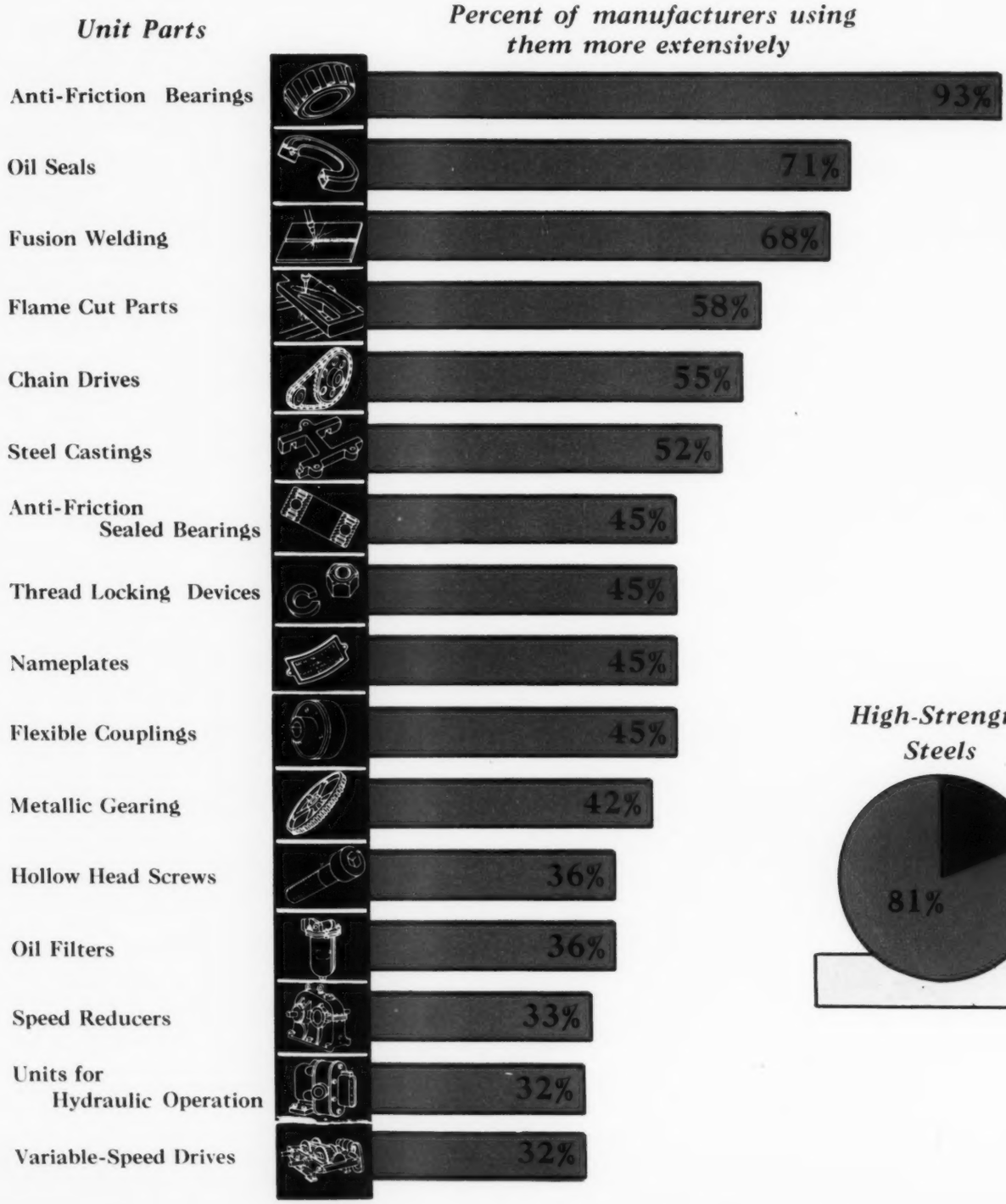
Increase the Use of Welding

In this group are included 80 manufacturers of pumps, compressors, shop cranes and foundry, steel plant and power plant machinery



Designers of Mobile Machinery Adopting Low-Alloy Steels

In this group are included 31 manufacturers of power shovels, mining machines, road machinery, crushing and screening equipment, locomotives and similar machinery



Some of the Comments

"The tendency toward the more extensive use of electric welding is especially more pronounced." *Road Machinery.*

"We are using more alloy cast iron and more springs." *Crushing Machinery.*

"Replacing castings with flame cut steel parts arc welded together." *Agricultural Machinery.*

"We specify more machined finishes than formerly." *Farm Machinery.*

"Our aim is to provide better controls and adjustable speeds and therefore we are using variable-speed drives and indicating instruments." *Pulverizing Machinery.*

"The appearance factor can no longer be ignored in the design of construction machinery . . . . . We are making considerable use of clad sheets." *Power Shovels.*

"We do considerable metal spraying for corrosion resistance." *Concrete Mixers.*

"Because of its advantages of speed, simplicity, ease of control and other obvious reasons, we are using more hydraulics on our new designs." *Power Shovels.*

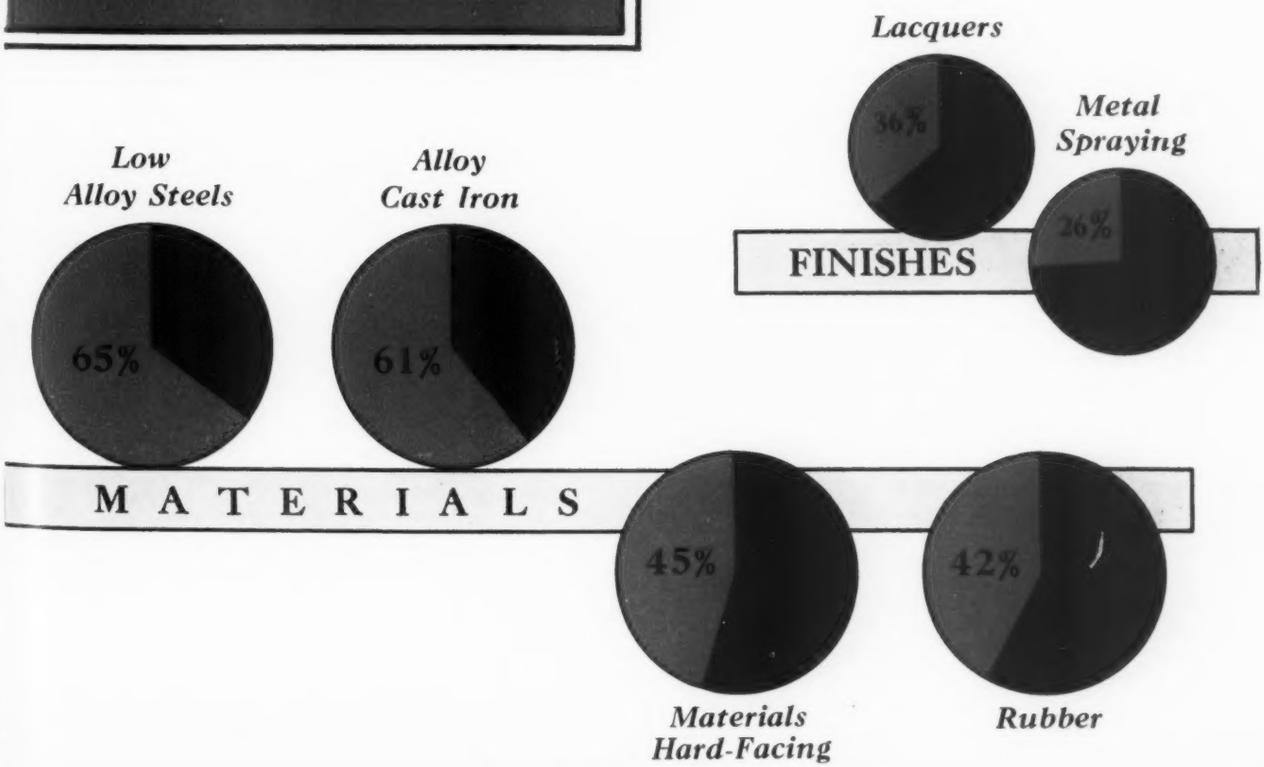
ADDITIONAL TRENDS

OUT of 10 manufacturers of road building machinery and power shovels, all of them are extending the use of welding and 80 per cent are going in more for flame cutting. All are using anti-friction bearings, 4 are using the grease sealed type more extensively, and 80 per cent are making more use of oil seals. Nine are using heat-treated alloy steels while 6 are adopting low-alloy steels that possess high strength in the as-rolled conditions. Half of these manufacturers are using hard-facing materials such as the tungsten-carbides. Four of them report a greater use of hydraulic operation.

Of the power shovel and concrete mixing machine builders, 68 per cent are using chain drives more extensively.

Three out of 4 manufacturers of farm equipment are using more resistance welding, oilless bearings, clad sheets and hard facing materials. One states that he has not increased the use of oilless bearings because they do not stand up on the types of applications he has in mind.

Out of 7 manufacturers of pulverizing and crushing machinery 5 are using variable-speed drives and 6 are using hard facing.



Automotive and Aeronautical Designers Favor Stampings and Formed Sheets

In this group are 40 manufacturers of airplanes, automobiles and automotive engines, including engines for railroad service and a few manufacturers of accessories and parts such as clutches

Some of the Comments

"Small and light-weight devices for automatic motor and hydraulic controls are long-felt needs." ***Aircraft.***

"Aluminum phenolic-resin varnish is gaining in popularity. The finishes must have high resistance to salt water corrosion." ***Aircraft.***

"Chrome-moly tubing, welded, is 'standard' construction for landing gears and engine mounts." ***Aircraft.***

"We are using considerable Dowmetal for the reduction of weight of moving parts and silencing by reducing impact." ***Automotive Accessories.***

"Tendency to use more etched and lithographed parts for automotive parts such as panels and scuff plates." ***Automotive Parts.***

"We have done most of the development on the use of magnesium alloys for aircraft wheels and brakes." ***Automotive Accessories.***

"Trend is toward more extensive welding to be applied especially where weight reduction is essential." ***Diesel Engines.***

"Our latest engine, 10-cylinder, 2,000-hp. V-type has cast aluminum alloy pistons, forged aluminum piston pin and crankpin housings, and all covers of aluminum." ***Diesel Engines.***

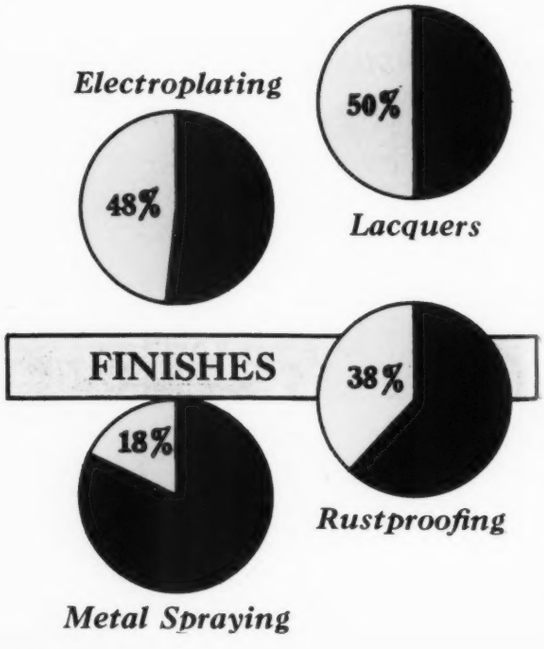
ADDITIONAL TRENDS

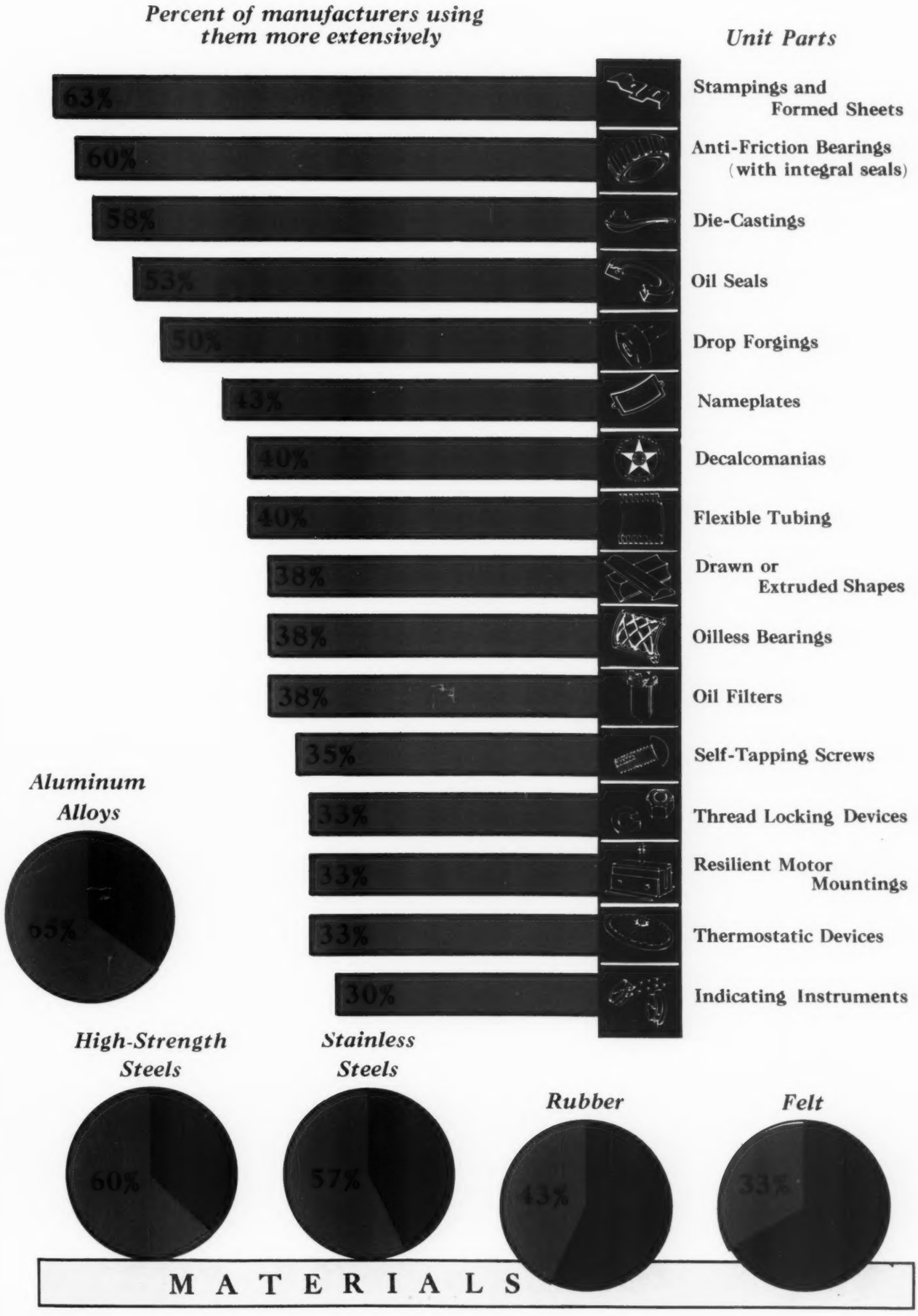
OUT of 9 manufacturers of aircraft, two-thirds are using anodic coatings on aluminum, 5 are using clad sheets more extensively, one-third are using more metal spraying and are increasing the applications of hydraulic operating units.

All of the 12 manufacturers of automotive, marine and industrial engines are using oil filters, all but one report a more extensive use of oil seals, three-fourths of them are using anti-friction bearings more extensively, and half of them are applying more thermostatic devices.

A total of 14 manufacturers in this group of 40 report further applications of magnesium alloys (Dowmetal) and 9 of them are finding new uses for clad sheets such as nickel or stainless clad steel.

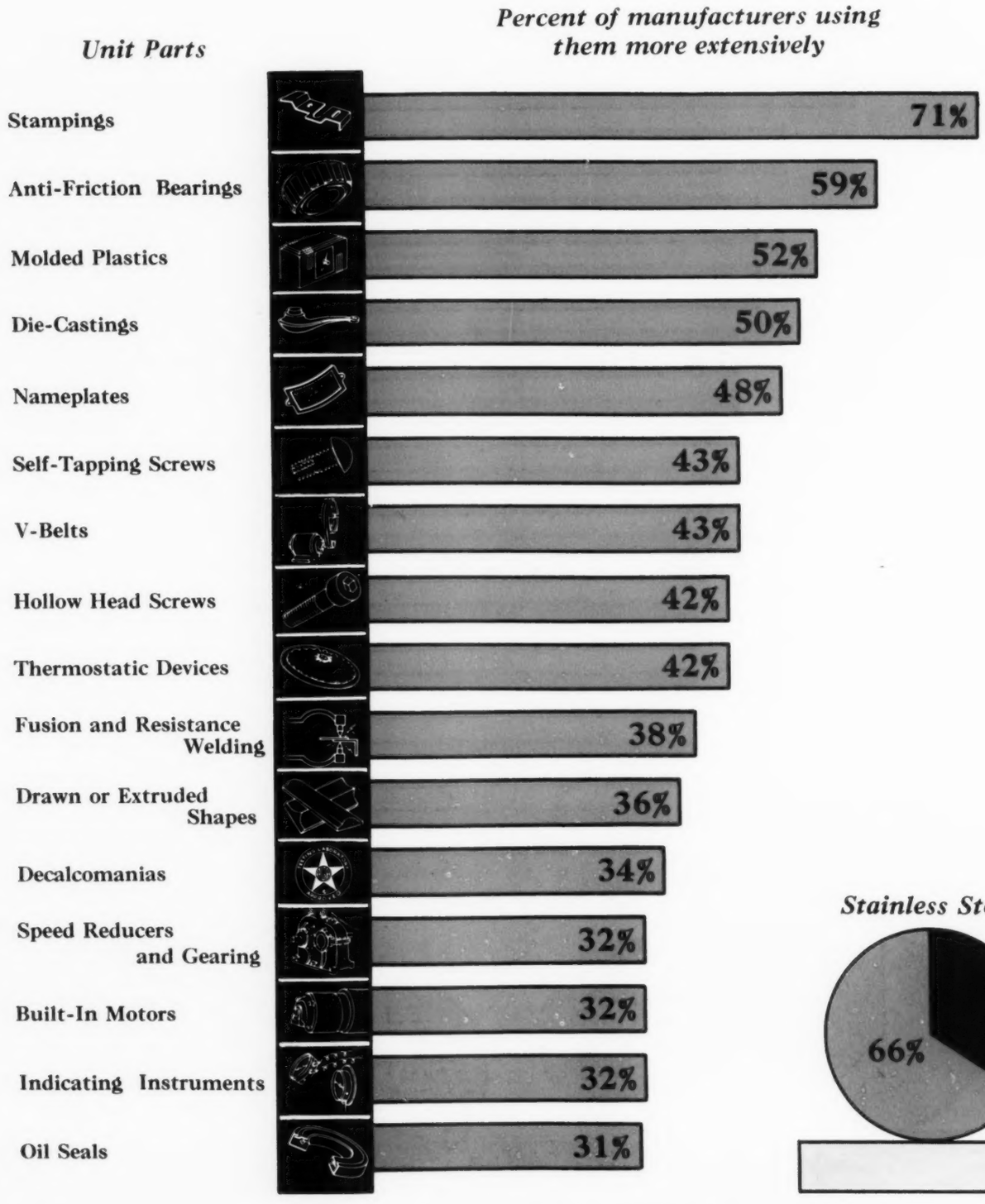
Beryllium copper was reported by 5 of the manufacturers—2 automotive parts manufacturers, 2 aircraft engine manufacturers, and an aircraft manufacturer. No details about any of these applications were given. Alloy cast irons are reported by 40 per cent of these manufacturers, low-alloy steels by 30 per cent, and 33 per cent report a greater use of felt and cork.




Percent of manufacturers using them more extensively
Unit Parts
63%
Stampings and Formed Sheets
60%
Anti-Friction Bearings (with integral seals)
58%
Die-Castings
53%
Oil Seals
50%
Drop Forgings
43%
Nameplates
40%
Decalcomanias
40%
Flexible Tubing
38%
Drawn or Extruded Shapes
38%
Oilless Bearings
38%
Oil Filters
35%
Self-Tapping Screws
33%
Thread Locking Devices
33%
Resilient Motor Mountings
33%
Thermostatic Devices
30%
Indicating Instruments
Aluminum Alloys
05%
High-Strength Steels
60%
Stainless Steels
57%
Rubber
43%
Felt
33%
MATERIALS

Light Machinery and Equipment Feature Stampings

In this group are included 88 manufacturers of typewriters, business machinery, hospital sterilizers, laboratory apparatus and equipment, instruments and miscellaneous products



Plastics and Die-Castings

ADDITIONAL TRENDS

TWENTY manufacturers in this group report the more extensive use of beryllium copper, the applications including springs, dies and diaphrams and similar parts in cameras, electrical instruments, electrical control devices and valves.

Eighteen companies including manufacturers of marking and checkwriting machines, cameras, winding machines and electrical devices reported new applications for magnesium alloys.

Seventeen manufacturers including electrical circuit breakers, cameras, tools, valves, automotive devices, are finding new uses for leather.

Prefinished sheets are being used more extensively by 11 manufacturers of reflectors, business machines, hospital sterilizers, tanks, metal furniture and radio parts.

Chemical rustproofing is receiving wider use among 23 manufacturers of electrical devices, sporting goods, radios, scales, calculating machines and many other products.

Twenty manufacturers of electrical products, paint spraying devices, highway signals, power plant devices, radios, scales and other products report a more extended use of porcelain finishes.

Twenty manufacturers of electric controls, calculating machines, highway signals, motion picture projectors and other products, are extending their uses of laminated plastics.

Some of the Comments

"Since we have gone into metal tubes we are using many drawn and extruded products. We are also beginning to use considerable tungsten-carbide." ***Radio Tubes.***

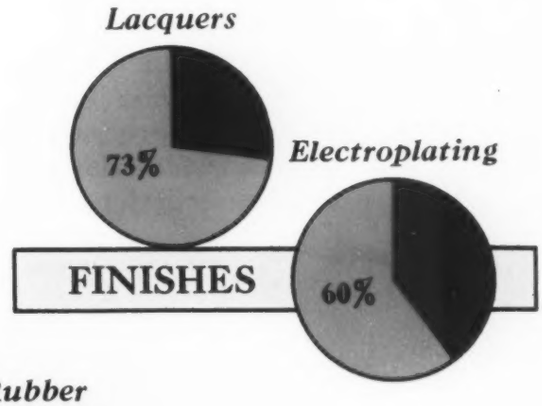
"Arc welding has been used by us for about two years and we are finding many new uses for it." ***Gas Heaters.***

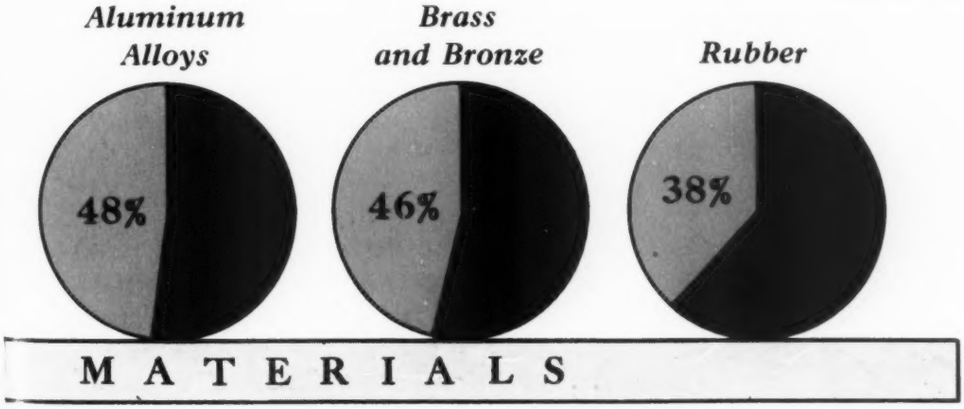
"Self-tapping screws are being adopted as standard in all new designs. Assembly time has been decreased and loose bolts and nuts eliminated." ***Heating and Lighting Appliances.***

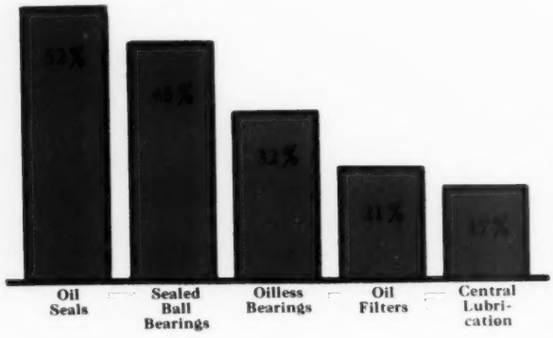
"Tendency to produce machined parts by milling from bar stock instead of forging." ***Shotguns.***

"The possibilities of metal spraying in our indsutry is almost unlimited. We have used silver sprayed contacts in all our indoor disconnect switches and the use of aluminum sprayed terminals is becoming quite the order." ***Electric Switches.***

"We are giving some consideration to molded plastic covers." ***Adding Machines.***





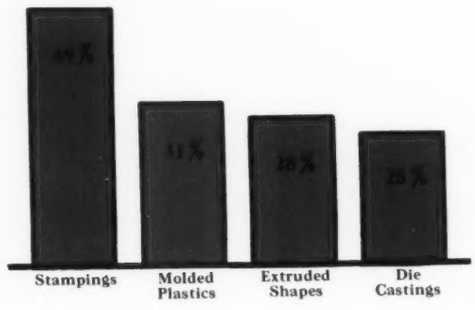


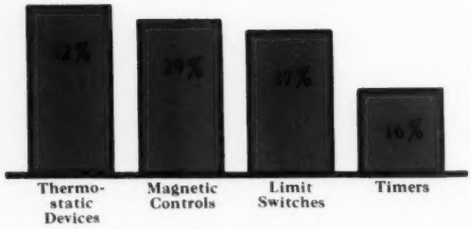
The importance attached to preventing or avoiding lubricant leakage is reflected in the great number of further applications of oil seals, sealed type anti-friction bearings and oilless bearings, while greater use of oil seals and oil filters is a natural accompaniment to the growth in the adoption of central lubrication

Summary of Data Discloses Interesting Basic Trends

Figures given by designing engineers on the parts and materials that they are using more extensively reflect design aims and requirements that are being emphasized in the development of new and improved products

The advantages of one-piece construction, an economical method for the quantity production of complicated shapes and curved surfaces, and a smooth surface finish and appearance are three reasons for the wide adoption of these four types of construction





Four items, the increasing use of which reveals the great amount of attention being given to making machines more automatic in operation and to adding safety features

Trends in Product Development

TYPES OF CONSTRUCTION BEING USED MORE EXTENSIVELY

Based on 363 Companies

Molded Plastics	110	Bronze	99	Flame Cut Parts	124
Stampings	180	Drawn or Extruded Shapes	101	Fusion Welding	150
Steel Castings	135			Resistance Welding	105
Die Castings	92	Drop Forgings	96		
Aluminum	171	Drawn Tubing	116		

MACHINE PARTS AND UNITS BEING USED MORE EXTENSIVELY

Based on 363 Companies

Ball or Roller Bearings	244	Chain Drives	97	Electronic Controls	50
With Integral Seals.	165	V-Belts	204	Thermostatic Devices	116
Sleeve Bearings	58	Flexible Shafting	27	Electrically Operated Valves	83
Oil Seals	189	Flexible Couplings	120		
Oiless Bearings	116	Magnetic Clutches	24	Units for Hydraulic Operation	77
Central Lubricators	62	Non-metallic Gears	74		
Oil Filters	76	Metallic Gears	113	Timers	58
Flexible Tubing	92	Resilient Motor Mountings	81	Counters	45
Hollow Head Screws	170			Recording Instruments	66
Self Tapping Screws	114	Built-in Motors	105	Indicating Instruments	82
Thread Locking Devices	102	Motor-reducer Units	95	Built-in Lighting	50
Speed Reducers	116	Magnetic Controls	107		
Variable-Speed Drives	109	Limit Switches	99		

MATERIALS BEING USED MORE EXTENSIVELY

Based on 363 Companies

Low Alloy Steel	126	Bronze	133	Rubber	133
Stainless Steel	198	Beryllium Copper	40	Cork	69
High Strength Steel	185	Aluminum Alloys	164	Felt	103
Nitralloy	52	Magnesium Alloys	27	Fibrous Glass	15
Alloy Cast Iron	178	Clad Sheets	37	Leather	51
Copper	59	Laminated Metals	29	Plywood	38
Nickel	55	Hard Facing Materials	50	Rare Metals	12
Cu Ni Alloys (Monel)	81	Laminated Plastics	51	Other Materials	21
Brass	109	Vulcanized Fiber	49		

FINISHES BEING USED MORE EXTENSIVELY

Based on 363 Companies

Lacquer	183	Nickel Electroplating	90	Anodic Coatings	42
Porcelain	50	Other Electroplating	48	Chemical Rustproofing	74
Chromium Electroplating	171	Pre-finished Sheets	29	Nameplates	173
Cadmium Electroplating	148	Metal Spraying	75	Decalcomanias	91

New Things Offered by I

Alex B. Silverberg
Courtesy of U. S. Camera, 1936

Industry for Improving

PRODUCT DESIGN

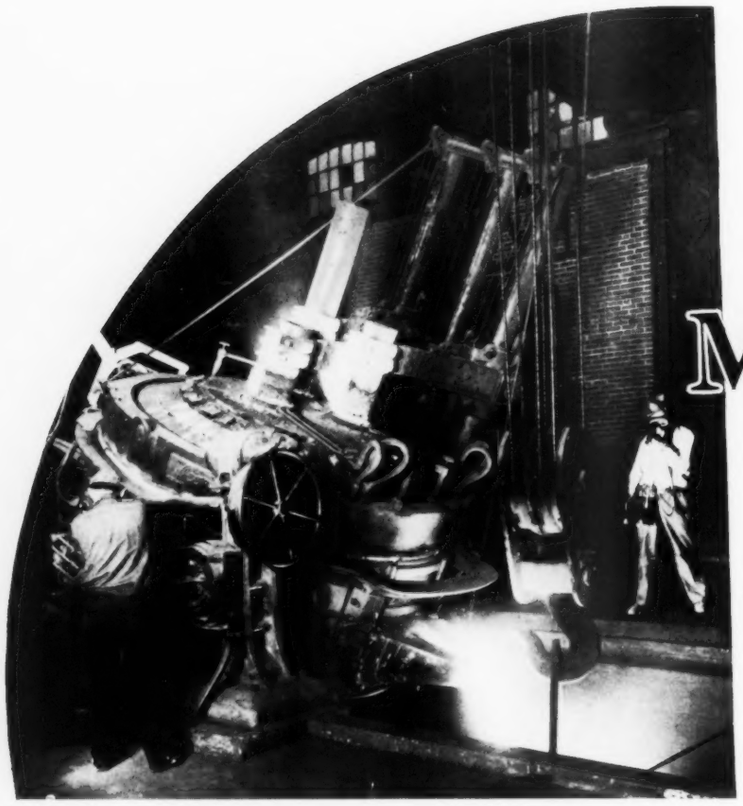
A resumé of developments in machinery parts, materials, production processes and finishes that have opened new possibilities and opportunities for the creation of better and more desired products

IMPROVEMENTS are being made continuously in practically all types of engineering materials, machine parts and types of construction and production processes. To separate the new from the old is impossible. Not all the *new* developments set forth here are new in the sense of recent in discovery. But such are new in that they have reached the stage of commercial use within the past two years.

In many instances there is nothing dramatic about the development, yet it may have far-reaching results. The possibilities in the use of fibrous glass that can be spun and woven, stir the imagination. On the other hand, even though there may be nothing dramatic about it, the developments of a finish capable of resisting high temperatures may be a much more important fact for some designers to know.

It is often difficult or impossible to credit or attribute a given development to any one company. Usually it is found that a number of companies have made similar developments and there is no way of finding out the names of all of them. Therefore, although all of the information in this review of developments has been obtained from and checked with recognized companies, the names have been purposely omitted. Trade names are given only where they serve to convey a definite meaning not otherwise easy to express.

HOWEVER, if any reader desires further information on any new thing or development mentioned in these articles, the names of the companies supplying the information and further details on any specific development will be furnished on request. In order to simplify this as much as possible, at the end of each paragraph or paragraphs wherein a new development is described or discussed, there will be found a number in parenthesis. Readers writing for further information should simply give this number in order to specifically identify the item on which further information is desired. It should be understood, however, that in giving the names of companies we can give only those names of companies that we know have available the improved products to which the item refers. It is entirely possible, and in many instances most likely, that other companies also have available a similar development.



Bethlehem Steel Company

Many Developments in METALS and ALLOYS

IN THE field of ferrous alloys, the development having the most widespread effects has been that of the low-alloy steels possessing high strength in the as-rolled condition. A great variety of these steels are now made by a great number of the steel companies (see *P.E.* Oct. 1936, p. 389 for the chemical composition and physical properties of some of the typical moderately alloyed steels). Variations in compositions are primarily for the purpose of obtaining to a greater extent certain properties such as weldability, formability and corrosion resistance, although all of these steels possess these properties to a marked degree. Their general characteristic is a low carbon content with small percentages of silicon, manganese, copper, chromium, nickel or molybdenum as the alloying elements. Their yield strength ranges between 50,000 and 70,000 lb. per sq.in. and they are characterized by a high ratio of yield strength to ultimate tensile strength and a corrosion resistance considerably higher than that of ordinary carbon steel or even plain copper bearing steel.

First finding their most general adoption in the field of railroad equipment design, these low-alloy steels are now being used to a considerable extent in the automotive field, for construction and mining machinery, tractors and portable equipment in general.

¶ As an example of one of the newer developments in the high-tensile steels, there has been put on the market within the past year a high-tensile steel containing less than 0.12 per cent C, 0.20 to 0.80 per cent Mn, 0.35 to 0.75 per cent Cu, 0.25 to 0.75 per cent Ni, and 0.25 per cent Mo. For both cold and hot-rolled sheets, this material possesses a tensile strength of 66,500 lb. per sq.in., and a yield point ranging from 45,000 to 52,000 lb. per sq.in. with an elongation of 27 per cent in 2 in., the Rockwell hardness number being B-72. It is reported that the machining qualities of this steel are excellent and that it can be flanged, riveted, welded or cold formed readily. It is available in both plate or sheet form. (1)

¶ Another one of these new low-alloy high-strength steels has less than 0.12 per cent carbon and is alloyed with 0.50 to 2.70 Mn, 0.10 to 0.15 P, 0.05 S (max) and 0.30 Si (max); with 0.90 to 1.25 per cent copper and 0.45 to 0.65 per cent nickel. This material has a tensile strength of about 75,000 lb. per sq.in., and a yield point of 60,000 lb. per sq.in. minimum, with an elongation of 20 per cent in 2 in., for plates or sheets less than 0.125 in. thick. On a cold bend test for sheets less than 0.063 in. thick, the material will bend through 180 deg. flat on itself. Its Izod impact value is 65 and the endurance limit is 45,000 lb. per sq.in. Its resistance to atmospheric corrosion is appreciably higher than plain copper bearing steel. Procurable in sheets, strips, plates and structural sections, the material can be gas-welded easier than plain carbon steel, and can be readily arc-welded with the various commercial heavy-coated rods. (2)

Simplification of Alloys

Simplification of types and the increasing use of lower alloy steels, particularly in the automotive industry, is especially marked in the nickel groups, the 5 per cent nickel steel giving way to the 3½ per

cent nickel-moly, and the nickel-chromium SAE 3115 steels being used in increasing amounts. One company reports that there are no longer large tonnages of vanadium steels being produced by them, these steels being replaced by chromium steels, particularly SAE 5150, containing 0.80 to 1.10 chromium. Also many modifications of standard grades are being introduced. (3)

Stabilized Stainless Steels

Titanium bearing stainless steel and columbium bearing stainless steel are being used extensively. The addition of columbium, in excess of ten times the carbon content, does not materially reduce the corrosion resistance but effectively prevents carbide precipitation, thereby improving the welding quality. Similarly the addition of titanium in an amount equal to four times the carbon content, reduces or eliminates carbide precipitation during welding, although it also reduces the corrosion resistance approximately 20 per cent. (4)

¶ One steel manufacturer states that a stabilizing alloy such as columbium or titanium is quite often essential in order to obtain the proper welding quality of the solid stainless steel sheet or plate. Because the stainless steel has low heat conductivity, the welded area may be held in temperatures ranging from 1,700 deg. to 1,800 deg. F. for a sufficiently long time to cause carbide precipitation in straight 18-8 stainless to take place. However, in 18-8 stainless clad sheets the more rapid heat conductivity of the mild steel backing permits the temperature to drop with sufficient rapidity so that there usually is very little, if any, carbide precipitation. This company also reports that in spite of the fact that most of their applications of clad stainless sheets have been with the straight 18-8 stainless, they have had no report of weld corrosion failures in any of their applications. In fact, in the reported failure of an 18-8 stainless clad steel tank which contained mixed acids, the weld and weld areas had resisted corrosion equally as well as any of the other parts of the surface. In this case, no type of stainless steel would have been resistant to the particular acid mixture. But, the failure does illustrate the point that good welding stability can be procured in straight 18-8 clad sheets without additions of titanium or columbium. (5)

¶ Another recent development in stainless steels has been the addition of molybdenum, 2 to 4 per cent, to stainless steel containing 16 to 19 per cent chromium and a maximum of 14 per cent nickel. For many applications this molybdenum bearing steel has corrosion resisting properties superior to those of the straight 18-8 alloys. It is the only alloy that has been found to be satisfactory in the sulphite paper mills. The addition of molybdenum is not intended as a stabilizing element to reduce carbide precipitation. It is true that in many cases the welded area of the molybdenum bearing stainless steel is superior in corrosion resistance to the straight 18-8 solid stainless, but that is because of the inherently greater corrosion resistance of the molybdenum bearing steels and not because molybdenum is a stabilizing element, as some engineers are inclined to think. (6)

Steels for Abrasion Resistance

During the past year there has been considerable interest in chrome-nickel steels of the SAE 3340 type for abrasion resisting equipment such as liners for dredge pipes. Active interest has also been manifested in steel plates containing approximately 0.50 per cent molybdenum for vessels fabricated by welding, particularly where the vessels are designed for service at temperatures above 750 deg. F. The addition of molybdenum considerably increases the creep strength value of the steel. Also, because of the excellent welding properties of the so-called moderate high-strength steels containing approximately 0.50 per cent molybdenum, this material is being used extensively for diesel engine frames and housings. Another interesting development has been that of special carbon steels for use in welded plate vessels intended for service at temperatures as low as minus 100 deg. F. (7)

¶ In the exceptionally high alloy steels, used primarily for cutting, there has been developed a steel containing 20.50 per cent tungsten, 4.25 per cent Cr, 1.30 per cent Va, 12.25 per cent Co and 0.60 per cent Mo with a carbon content of 0.80. It is claimed that this material can be used at higher cutting feeds and speeds on cast iron and heat-treated materials than any other type of high-speed steel thus far developed. (8)

¶ Along the same lines, there has been developed a die steel for hot work. This steel, approximately 0.32 C, 4.75 Cr, 0.75 W and 1.00 Mo, is claimed to have exceptional toughness at elevated temperatures and is therefore splendidly adapted for dies that are to be water cooled when in operation. Although the material is comparatively low in alloy content, it has definite secondary hardness and can be used at a temperature as high as 1,050 deg. F. without loss of hardness. It was developed primarily as a die steel for hot work such as dies for die-castings, forging dies, gripper dies, hot forming dies and similar applications. (9)

Tubes for High Temperature

New low alloy steels for tubing, such as is in wide use in the refining industry and to some extent in the power field, have been developed further. In addition to a 4-6 per cent chrome-molybdenum steel, one company has developed an alloy containing 1.15 to 1.65 per cent silicon, which, at 1,500 deg. F. is approximately 23 per cent more resistant to oxidation than is carbon steel, and compares favorably with 4-6 per cent Cr-Mo. In the temperature range of 1,000 to 1,200 deg. F. this steel has almost twice the strength of carbon steel. (10)

¶ Another alloy is a chrome-moly steel of slightly lower chromium content than the 4-6 Cr-Mo. This alloy is suitable for use where corrosion resistance is a major consideration, but where conditions do not warrant the cost of higher chromium steels. The alloy compares favorably with 4-6 per cent Cr-Mo with respect to sta-

bility, strength and oxidation resistance and tests indicate that its resistance to corrosion is approximately half that of the 4-6 per cent Cr-Mo steel. (11)

New Deep-Drawing Steels

Recently one company announced full commercial production of a "stabilized" steel possessing extra-deep-drawing and non-aging properties with all stretcher strains permanently eliminated. This steel retains indefinitely all of the properties of temper-rolled steel, making pre-fabrication treatments unnecessary, regardless of the length of time that the metal has been in stock. It is also claimed that this new material is free from blue brittleness as indicated by the fact that the tensile strength of the material does not increase in the blue brittle range as in the case of mild steel. It also possesses the further advantage over ordinary mild steel in that the amount of temper rolling commonly used for tempering the sheet does not impair the ductility. This advantage is most important where severe drawing requirements are needed and which ordinarily demand a close adjustment of the amount of temper rolling to prevent breaking on the one hand and stretcher straining on the other. (12)

¶In the field of casting, perhaps the most striking development has been the commercial adoption of the Randupson process. In this process the castings are produced in cement bonded molds resulting in a superior surface smoothness, freedom from warpage and a more dense casting. This process, originally developed in France, is now being used by a considerable number of foundries in this country, both for the production of steel castings and also non-ferrous castings. (13)

Castings for Wear Resistance

Within the past 18 months one company has developed a number of new applications for a 28 per cent chromium cast iron which has an exceptional resistance to pure abrasive wear such as is encountered in centrifugal pumps, parts for clay working machinery, liner plates and similar applications. It is claimed that this material has been found to outlast other hard irons as much as 6 to 1. A somewhat similar high chromium iron has also been introduced for high temperature service. One manufacturer has successfully solved the problem of pouring a single casting out of two different irons, thereby securing castings made up of two metals which could not be welded together by any of the conventional methods. (14)

In the manufacture of high manganese steel castings (Hadfield type) the most important advance has been the adoption of the continuous principal for heat-treating. This minimizes the scaling and decarburization, which has always been a difficult problem especially with light manganese steel castings. The decarburized surface results in considerable decrease in wear resistance. (15)

New Permanent Magnet Alloys

New permanent magnet materials possessing greatly improved magnetic and physical properties have become commercially obtainable during the past year. These new materials not only have exceptional magnetic properties but are also relatively low in cost. Four such materials are the nickel-aluminum-iron alloys, cobalt-molybdenum-iron alloys, cobalt-tungsten-iron alloys, and a non-metallic material composed of cobalt and iron oxide. With reference to the first three of these materials coercive forces more than four times greater than obtainable in the old cobalt steel magnets are attained, and their magnetic properties do not suffer much when subjected to high temperatures.

In using these new materials it is necessary to modify the design, because of their higher magnetomotive force, requiring a shorter length of magnet for a given duty. In general it is not permissible to merely substitute the new material shape for shape, except the cobalt-molybdenum-iron alloys which may have characteristics sufficiently similar to those of cobalt steel to permit the two materials to be used interchangeably.

The cobalt-molybdenum and cobalt-tungsten magnet alloys can be machined and forged with no more difficulty than the tungsten and chromium magnet steels now in common use. Both the nickel-aluminum and the oxide materials have limitations imposed by their physical properties, namely because the nickel-aluminum alloy has a coarse grain structure and possesses no great mechanical strength. It is brittle. Neither forging or machining is possible, thereby limiting shaping methods to casting and grinding. With reference to the sintered oxide material, its mechanical strength is lower than that of the nickel-aluminum alloys. It might be termed fragile. It is necessary to provide some protection such as a film of metal sprayed or plated on the surfaces.

On the basis of magnetic performance, with the cost of nickel-aluminum magnets taken as unity,

the relative cost of oxide magnets is estimated at 1.2; of chromium steel and cobalt-molybdenum alloy magnets at 1.5; cobalt steel magnets at 2; and cobalt-tungsten alloy magnets as 2.5. These figures are only for similar simple shapes which readily can be cast or molded and where little machining and little mechanical strength are required. Different conditions and details of the design might alter the relationship considerably. (16)

¶In the steel castings industry much progress is being made on grain control, both as a result of new furnace practice and better heat-treatment. There is a concentration of effort to improve the already existing known steels and make them more specifically useful for definite applications. As one steel casting company reported, during the past two years there has been a steady rise in the percentage of alloy steels produced in proportion to the total production. This particular foundry is giving special attention to the castings of low-alloy, high-strength steels. (17)

Nickel-Chromium Alloys

Among the non-ferrous alloys of the nickel-chromium type, one foundry reports that they are now producing a new alloy with a combined nickel and chromium content of 80 per cent, with copper, molybdenum and tungsten constituting the remainder. The iron content is less than 5 per cent. Obviously, the composition of this alloy makes it expensive, but it is particularly useful for applications where a maximum corrosion-resistance is desired in a machinable alloy. (18)

Nickel-Copper-Aluminum

In his paper before a recent meeting of the American Chemical Society, Mr. Robert J. McKay of the International Nickel Company, brought out the recent development of a nickel-copper-aluminum alloy, obtained by the addition of 3½ per cent aluminum to Monel metal. This improves many of the mechanical properties of the Monel metal without substantially changing its corrosion resistance, the increased mechanical properties being obtained by heat-treatments, or a combination of heat-treatment or cold-rolling. In the form of cold drawn rods, this material possesses an ultimate strength as high as 165,000 lb. per sq. in., and as hot-drawn spring wire it has an ultimate strength of 175,000 to 200,000 lb. per sq. in. The rod material has a yield point of about 125,000 lb. per sq. in., and in 2 in. an elongation of 21 per cent.

Other developments in copper-nickel alloys as reported by Mr. McKay include the alloying of pure nickel. A copper-nickel alloy containing 20 to 30 per cent nickel has been developed particularly for use as condenser tubes because of its high resistance to salt water corrosion and the ease with which this material can be formed into finished tubes.

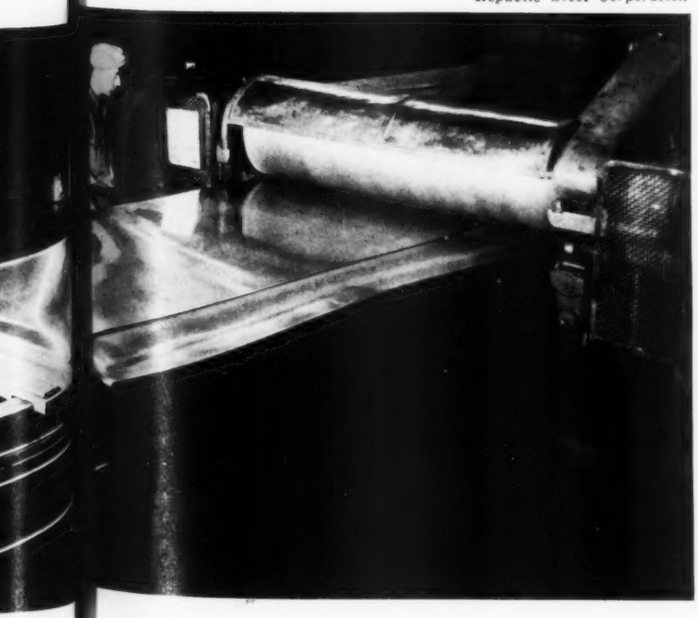
Hard-drawn stainless steel wire for springs has come into extensive use for corrosion and heat resistance. The analyses ordinarily used correspond to 18 chrome-8 nickel. This material is finished with high tensile strength and compares favorably with steel spring wires in regular use as regards strength, ductility and toughness. It is also finished with a metallic coating which acts as a lubricant in the coiling dies, thereby overcoming one of the main objections to the fabrication of stainless steel springs, namely excessive tool wear. (19)

Seamless Drawn Tubing

Seamless cold drawn tubing is now obtainable in a wider range of different grades of materials including low and medium carbon steels, pure nickel, nickel-silver, Monel metal, chrome-moly and stainless steels. Standard size tolerances are much closer than formerly available. As an example, the smaller sizes are regularly produced to a total of 0.002 in. tolerance, while on some of the extremely small sizes of tubes the tolerances are as little as 0.0005 in. A new development is a method of making composite tubes. In the manufacture of such composite tubes, two or more tubes of different metal are drawn together through a die over a mandrel. The result is an extremely strong mechanical bond between the tubes. Such tubes are used primarily where it is desired to have a corrosion-resisting surface on a strong steel tube. They should not be confused with bi-metal tubes wherein the outer and inner tube are fused together before being drawn to the smaller diameter. (20)

¶With further reference to clad steels, there has been a very noticeable trend within the past year toward a greater use of light gage sheets primarily for such things as kitchen table tops, kitchen cabinets, soda fountains, back bars, shelving and paneling. This trend is partly explained by the fact that stainless clad steel, thickness 20 per cent stainless and 80 per cent soft steel, can be formed and drawn much more easily than solid stainless steel. This fact, combined with the in-

Republic Steel Corporation



herent economy in the use of clad steel is undoubtedly responsible for the increase in the demand for these lighter gage sheets. (21)

Devclopments in Bearing Alloys

Among the new bearing materials are the cadmium-silver-copper alloys. It is claimed that these new alloys offer a greater resistance to corrosion and that less running clearance in the bearing is required than with the copper-lead type, and that prolonged periods of heating at elevated temperatures has little effect on the strength and hardness. Melting point is about 600 deg. F. (22)

Beryllium-Copper Alloys

In beryllium-copper alloys, there have been two particularly significant developments during the past year. One is the use of beryllium-copper cast molds in the plastic industry. These enable an appreciable saving in cost, in that the metal is cast directly against a model, thereby eliminating all the cost of die sinking. The savings are particularly great where the design of the part is intricate or ornamental. Another advantage of the beryllium-copper molds is that the material has a considerably higher heat conductivity, an important advantage when molding thermoplastics such as the acetate materials. (23)

¶ Beryllium-copper is now being used for bourdon tubes in pressure gages. One manufacturer reports obtaining a hysteresis less than 0.1 per cent and no measurable elastic lag at fiber stresses of 10,000 lb. per sq. in. This manufacturer claims that the beryllium-copper has more stable spring properties than any other material ever tried for this application. Similarly, beryllium-copper diaphragms are used in aviation instruments.

Beryllium-cobalt-copper is a new alloy in the beryllium-copper family. It contains about 0.4 per cent Be, 2.6 per cent Co, and the balance copper, has an unusual combination of tensile strength and electrical conductivity, particularly in sand castings. (24)

Aluminum in Larger Shapes

Developments in aluminum and aluminum alloys in the various shapes in which the material is available have been of a general nature. With reference to extruded sections, there has been a continuous development of new stock shapes for which there is no extra die charge.

In the field of aluminum and zinc die castings, maximum sizes are continuously increasing. From information available, the largest aluminum die casting now made commercially is a case 20 in. x 18 in. x 10 in. and weighing 20 lb. Also, there has been put on the market during the last year a new aluminum alloy in which the purity is controlled to give higher resistance of corrosion for special applications.

Larger structural rolled shapes are now available including channels up to 12 in., I-beams up to 5 in., H-beams up to 8 in., and 6 in. x 6 in. equal angles. The maximum length of structural shapes in heat-treated alloys is still 36 ft. for extruded shapes and 85 ft. for rolled shapes.

Sivyer Steel Casting Company

Strong alloy plates can be obtained in thicknesses up to 2.5 in., widths up to 120 in. and lengths up to 35 ft., subject to the limitation that the weight of an individual plate is 2,000 lb. maximum.

In aluminum screw stock, the latest is a free-cutting alloy which was developed primarily for use on automatic screw machines and has a machinability comparable with that of brass. (25)

Greater Use of Rare Metals

There is now a greatly increased commercial use of precious metals and precious metal alloys. Two factors have contributed to this. One is the decreasing cost of some of the precious metals, particularly silver. But of greater importance is the new methods that have been developed whereby the precious metals can be used economically. Striped silver bi-metals are being used economically for electrical contacts, or the silver can be sprayed on by some of the metal spraying methods or by electroplating.

Platinum and platinum-iridium is being used for lining dies for extruding glass. The advantage is the extreme hardness of this metal. (26)

¶ Tantalum is finding many commercial applications in addition to its use for laboratory ware. It is extremely ductile and possesses remarkable corrosion resisting properties. The metal is available in the form of wire, tubes, or sheets. It can be welded, drawn, hammered and hardened. One recent new application has been its use for a valve in fountain pens. Other applications include gaskets, tubing, valve parts, nozzles, ejectors, fuel injectors and many similar parts. (27)

¶ It should not be assumed that tantalum is so expensive that it can only be used in small quantities. Complete coils are made of this material for use in the chemical industry. In addition to tantalum there are a number of its alloys, namely tantalum-tungsten, tantalum-nickel and tantalum-carbide. (28)

Substitute for Platinum

Along with the greater need for the rare metals, there have been developed a number of alloys of somewhat lower price or cost, that can be used in certain applications in place of the rare metals. One platinum substitute is an alloy of 73 per cent nickel, 17 per cent cobalt, 7 per cent iron, 2.5 per cent titanium, and about 0.4 aluminum. The aluminum has little known influence and comes into the alloy as a impurity of ferro-titanium. This alloy has remarkable corrosion resistance, a tensile strength of about 102,000 lb. per sq.in., and at 1,160 deg. F. a tensile strength of 66,000 lb. per sq. in.; the principal application of this new alloy is for filaments in radio and rectifier tubes. As an electron emitter, this alloy is claimed to be far superior to platinum. (29)

¶ Another unusual alloy is composed of 99 per cent copper and the remainder chromium and silver in the approximate ratio of 8 to 1. Heat-treated, this alloy has a tensile strength of 75,000 lb. per sq. in. at a hardness of more than 150 Brinell. Its electrical and thermal conductivities are 90 per cent that of pure copper and prolonged heating at a temperature high enough to have caused marked alteration of these properties in steel, fail to change these values. Its high hardness and its electrical and thermal properties make it suitable for welding electrodes. (30)

New Alloys for Bearings

Along with the new cadmium-silver-copper bearings alloys that have been developed, there has also been developed a line of cadmium-nickel alloys. These have found a number of applications in the automotive industry as well as some specialized industrial fields.

Much work has also been done in the further development of high-lead bronze materials for use in main and connecting rod bearings, together with developing improved methods of lubrication. The chief problem in the development of these alloys is one of controlling the lead distribution and obtaining the uniform grain structure in the bearing side walls. This is a matter of foundry control, which has been receiving a great amount of attention from bearing manufacturers not only for the leaded bronze bearing alloys, but also all of the standard alloys. (31)

Airship Hindenburg has synthetic glass throughout

Developments in the NON-METAL MATERIALS

IT IS perhaps only natural that in point of numbers and importance the greatest recent developments in materials have been in plastics and other synthetic compounds. This relatively young phase of industrial chemistry has been very prolific in the birth of new species.

The latest announced new plastic is one that has the transparency of glass. This material is softer than glass, can be sawed, drilled, cut, polished and molded to any form, and weighs about half as much as glass. It is claimed that it transmits ultra-violet rays to a much greater degree than ordinary window glass, is practically non-inflammable and unaffected by sunlight. It is obtainable not only in sheet form and as a molding compound, but also as a liquid, in which form it can be used to impregnate wood, cloth, paper, stone and other materials, thereby rendering them proof against water, oils and chemicals.

Although the material is transparent in its usual form, it can be combined with dyes and pigments to produce varying degrees of color and translucency.

Although its field of application is still more or less in the experimental stage, it is being used to a great extent for windows in airplanes, wherein its light weight, toughness and non-shattering feature are great advantages. When applied in sheet form the material can readily be bent to any desired curve. (32)

¶ In their finished state most of the phenolic plastics look alike, but although the same in appearance there have been many new types of these materials developed for special applications. One

of the greatest needs has been for plastic molding materials that possess a greater resistance to shock and impact and that remain unaffected by water and moist atmospheres.

Manufacturers of phenolic molding compounds have reported that they have developed new plastics possessing an impact strength ranging from 2.88 to 29.00 lb. per sq. in., or 0.46 to 4.64 ft. lb. per in. of notch, these values being based on the A.S.T.M. D 256-34 T Izod test specifications. These shock-resistant molding materials are being used for collector rings, panels, instrument cases, camera cases, fishing reels and steaming bobbins and similar products requiring exceptional resistance to shock.

With further reference to plastics for camera cases, the material must be exceptionally resistant to the transmission of light in order to prevent fogging of the film. This required characteristic has been obtained in several of the plastics recently developed. (33)

¶ Also in the same category of high-strength impact-resisting phenolic molding material is one which possesses two to ten times greater impact strength than is obtainable in the general purpose of cellulose-filled molding materials. This material is used for refrigerator breaker strips, knife handles, telephone parts and also for camera and instrument cases. (34)

¶ A phenolic resin material in which there is disbursed graphite or a similar lubricant, can now be obtained for light-duty bearings and similar applications wherein a slight degree of lubrication is desired and the material must be resistant to rusting and corrosion. One of the first applications of this material has been for bumper shoes in automobile doors. It is claimed that despite the relative softness of the plastic material, there is no appreciable amount of wear. (35)

¶ One of the difficulties in the use of phenolic resins for electrical parts subjected to high voltages, as in ignition systems, has been the breakdown of the material because of carbon tracking. These carbon tracks are caused by the heat of the electric arcs breaking down the material. This type of failure is spoken of as arcing fatigue. Much work has been done in the development of phenolic resins that not only possess high dielectric strength but also possess a greater resistance to arcing fatigue. (36)

¶ Another development in phenolic resins has been that of compounds that are exceptionally acid and moisture resistant. One of such special compounds has been used for parts of the valve mechanism in toilet tanks wherein the material is continuously submerged in water. It is reported that after more than a year of service, these parts have shown no signs of swelling or warping. (37)

¶ Although not directly a problem of the designing engineer, there has been developed a new series of phenolic resins, introduced a few months ago, which cure with extreme rapidity. The significance of this is that it makes available a material that is exceptionally suitable for the rapid production of small parts, thereby appreciably reducing their cost. This rapid curing material has a lower specific gravity and higher mechanical strength than the ordinary phenolic resins. (38)

¶ Special phenolic resins have been developed for coating fabrics by calendering, the feature of these resins being that the fabric thus treated is resistant to most chemicals, oils, greases and water. Such fabrics have been used for waterproof adhesive tape, cloth for outdoors, upholstering material, slip covers and shower curtains. (39)

¶ As a result of a number of years of research there have been developed new synthetic resinoids for use as glue films for plywoods and similar adhesive purposes. The bond formed is chemically inert, free from attack by fungi and bacteria and is not affected by heat, cold and moisture. It is claimed that the bonding film will not stain delicate veneers. (40)

¶ Urea formaldehyde compositions with greater strength and impact resistance have made possible larger molded pieces of these materials. This has lead to the use of this type of plastics for such things as one-piece radio cabinets, large covers and housings, and globes or reflectors for lighting fixtures. In addition to the better physical properties, these improved urea-formaldehydes also possess exceptional flowing properties to enable the molding of wide areas of thick section. And for lighting fixtures, reflectors and globes, the material has to be translucent. Being shock resistant and capable of withstanding wide and rapid variations of temperature, it is superior to glass, in these respects. Its weight is about one-third that of glass and it is available in a wide range of colors. For simple shapes the cost is about the same as that of glass but for the more complicated and decorative shapes it is cheaper. (41)

¶ One company reports that it has added 4,000 shades to its listing of colors in which their urea-formaldehyde material is obtainable, making a total of almost 10,000 colors. Although many of these color variations are indistinguishable to the eye, they are important when it comes to matching colors. (42)

¶ In addition to the development of new materials, it was necessary to design larger presses for molding the larger pieces now available. Mold design and curing technique also had to be improved. It was developments such as these that made possible the housing of the Toledo scale and Enterprise meat chopper, and the large lighting fixture reflectors.

A number of translucent laminated plastic materials have been put on the market within the past year. Ranging in thickness from 0.15 in. to $\frac{1}{2}$ in., sheets of the material can be stamped to shape and printed or decorated. It was made possible by the development of clear transparent plastic materials for bonding sheets of paper. Principal uses have been for radio dials, signs and

illuminated instrument panels. The material is tough, flexible and resilient, resists moisture and temperature changes. (43)

¶ Improved cellulose acetate molding materials have greatly extended the field of the injection molding process, making possible the molding of small intricate parts at a relatively low cost. (44)

Synthetic Rubber

Much publicity has already been given to the synthetic rubbers now available. Principal developments in these materials have been in new forms that have been made available. Possessing all the principal properties of natural rubber, but in addition being resistant to oil, grease, gasoline and non-oxidizing in sunlight, the synthetic rubbers have quickly found many fields of application.

In the form of a molding powder, synthetic rubber is used for making gaskets, washers, printing plates, pump valves and similar parts. Its electrical properties are equal to those of natural rubber, making it suitable for electrical parts.

Special compounds of synthetic rubber possessing special qualities have been developed. These include resistance to high or low temperature, tear resistance, abrasion resistance and similar characteristics. (45)

¶ Mixed with ground cork synthetic rubber is used for pump valves, gaskets and similar applications. A relatively new development, its full field of possibilities is not known. (46)

¶ In addition to the material in solid form, synthetic rubber liquids are available. After drying, the liquid forms a thin film impervious to water, gasoline, oil and many chemicals. It is used for lining gasoline tanks and, in general, to make containers leak-proof.

The usual synthetic rubber is shipped vulcanized and can be processed exactly the same as natural rubber is processed. It can be used alone or mixed with rubber. Its applications include hose, tubing, electric cord insulation, gaskets and similar purposes. (47)

Felt Available in New Forms

Among new developments for mechanical purposes is a leather-coated felt wherein the leather is applied directly to the felt, not by lamination but in such a manner that the felt and the leather act as a unit. This leather coated felt is primarily for heat and sound insulation, it being used as head and side lining for truck cabs, taxicabs, automobiles and house trailers. It has also found applications for the lining of airplane cabins and there is also the possibility of its being used in radios.

Another development in felt is a new washer consisting of two layers of a high-grade wool felt with either one or two layers of an oil-proof, synthetic rubber compound placed in the center, or on one side and the center also. Such a felt-rubber combination is claimed to definitely prevent the entrance of dirt or grit whereas the oil-proof compound prevents oil from passing through the seal. Such felt washers are obtainable as plain washers or housed in a metal retainer. (48)

Fibrous Glass for Many Purposes

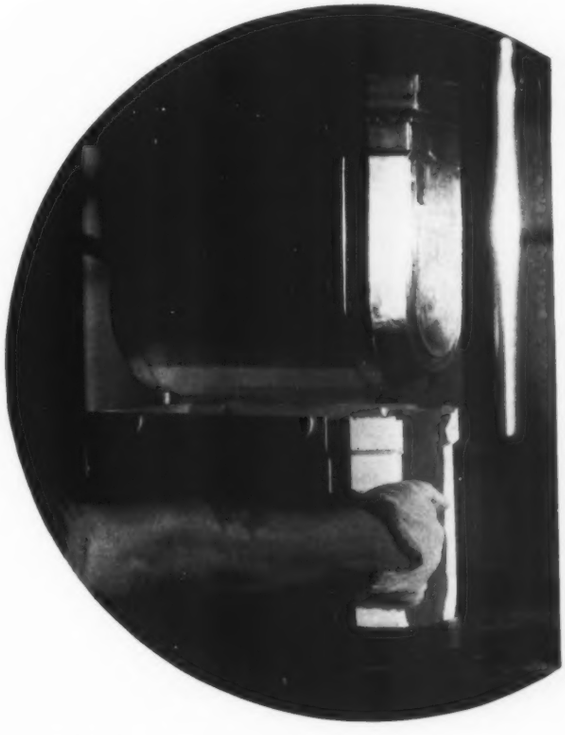
Among the basically new commercial developments of the past 18 months has been that of fibrous glass. Only 0.00025 in. diameter, the individual fibers are extremely flexible and can be spun into threads and woven into cloth. Or the material can be used directly.

One company has just announced "Rope Made from Glass," in diameters ranging from about $\frac{1}{8}$ in. to $\frac{1}{2}$ in. diameter, and described as "fire-proof, acid resistant, rot proof, water proof, vermin proof, adaptable for the electrical, mechanical and chemical industries." (49)

¶ In various forms such as blanketed between sheets of paper, fibrous glass is available for heat insulation for refrigerators, electric and gas ranges, hot water tanks, heaters and similar applications. It is entirely unaffected by temperatures up to about 900 deg. F., and does not absorb any moisture, the latter being a distinct advantage when used for the heat insulation of refrigerators, refrigerated display cases and similar products. (50)

¶ Many other possible applications of fibrous glass are in various stages of development, including tape for electrical insulation, draperies and fire-proof curtains.

In mechanical glassware the principal developments have been along the lines of improved processes which are making available glass parts of greater dimensional accuracy at a lower cost. One of the results of this has been the design and manufacture of a centrifugal pump for chemicals, made entirely out of glass. (51)



MANY of the improvements in electrical equipment relate to motor or circuit controls, and are primarily for the purpose of getting more compact and reliable units. As an example, compactness in the controls for 2 to 5 hp. a.c. motors used extensively in machine tools has been obtained mainly through the use of solenoid magnets, the electric hum in which has been minimized by allowing the individual solenoid laminations to float.

Contactor coils wound on a brass or copper sleeve are used in one design of starter for acceleration control. The eddy currents generated in the brass or copper sleeve when the control current is cut off, compels the magnetism to die down slowly. As much as 3 sec. might elapse before the intensity of the magnetism has died down to a point where the contactor armature will be pulled away by the spring. Although this type of control is more than 5 years old, the significant thing is that its capacity has been increased from 60 amp. in 1930 to 200 amp. in 1936. (52)

Silver Contacts in Great Use

Silver contacts, used by many of the control manufacturers, are credited with being an important factor in the development of more compact and better units. A small disk of silver is spot welded to the copper bar or striped silver bi-metal contacts are used. In some instances the silver is sprayed on.

Another trend in electric controls is toward standardized units that can be replaced easily. In some designs the control mechanism is mounted so that it can be swung out of the box or cabinet, thereby making it easy to wire the units. (53)

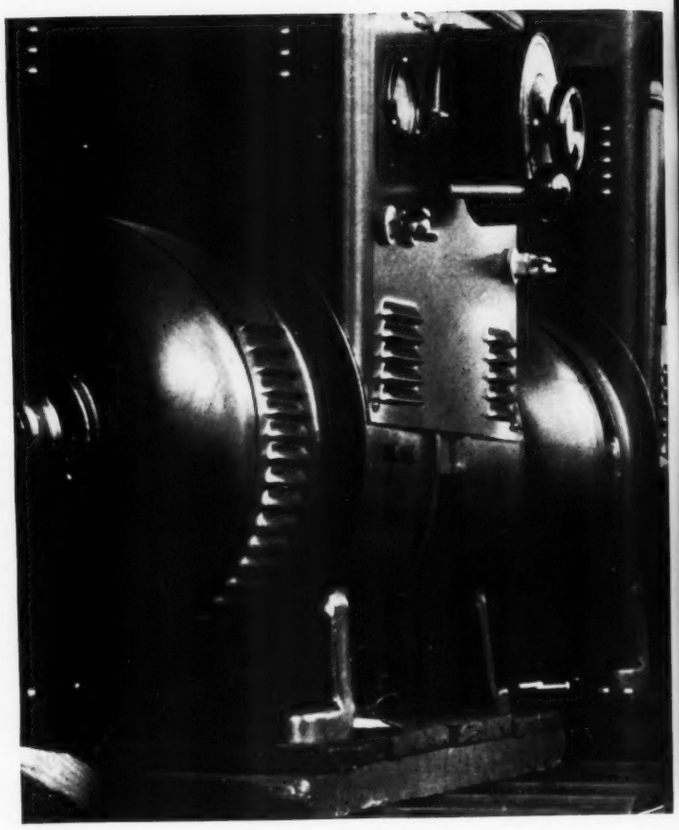
¶ Along the same line, in one design of reversing switch the contacts are removable as a unit and can be replaced without tools. For built-in applications the mechanism is mounted in a skeleton frame with an adapter plate in front. (54)

Mercury Switches in Metal Tubes

Mercury switches, usually made of glass, are now obtainable with unbreakable drawn steel housings with the outer surface treated to prevent corrosion. One contact is the metal casing, the other is mounted on a ceramic insulator. One such metallic envelope mercury switch is incased in molded plastic. Both of these switches are more compact than the conventional glass mercury switch and there is no possibility of breakage. (55)

¶ Many of the new designs of controls use molded plastic parts. Some are using aluminum to decrease inertia and thereby get quicker action. Self-lubricating self-aligning bearings are used. (56)

¶ Reflecting the demand for greater flexibility and interchangeability, there has been designed an interchangeable three-control switch unit wherein various arrangements can be obtained. Thus, in the one box there may be mounted units for normally open or normally closed circuits, two or three position transfer switches, or a pilot light can be installed in the same box. (57)



New Electric MOTORS

¶ To save space, one controller has removable walls so that one switch can be mounted right next to the other. Also, the switch opens when the door is opened, thus assuring that the fuse clips will be dead. (58)

¶ Another design of switch has the arc extinguishing structure on the moving contact instead of the stationary one. The arc extinguisher is in the form of a partition chamber totally inclosed except for two flaps at the bottom to receive the dual stationary contacts in separate cells. It is claimed that the suction action of the contacts fitting closely in the arcing chamber evacuates the small amount of air in the restricted inclosure, thus minimizing burning. (59)

Several designs of quick-acting pilot switches of exceptional sensitivity are now available. They are extremely small in size, about $1\frac{3}{8}$ x $1\frac{1}{2}$ x $\frac{5}{8}$ in., mounted in a molded plastic case and have a

Hobart Brothers Company

Improved controls and generators have obsoleted old welding equipment

and DEVICES

"quick make and break" action. Less than an ounce of pressure and a movement measured in thousandths of an inch is sufficient to cause the switch to operate. (60)

¶ For low voltages to operate pilot circuits, copper oxide rectifiers can be used to convert low voltage a.c. into d.c. One disk is good for 6 volts and 1 watt capacity, their operating temperature being limited to about 60 deg. C. (61)

¶ One interesting development has been the design of a geared type limit switch that operates similar to a counter. The successive wheels in the gear train move only one tooth pitch distance for every revolution of the preceding wheel, but the velocity of motion during this movement is equal to the angular velocity of the first wheel of the train. Thus, regardless of which wheel in the train is carrying the limit switch contact, the speed of break will always be high and will always be the same. Thus a quick make and break is obtained. (62)

¶ Numerous developments in other fields have contributed considerably to the improvement in control apparatus and devices. For example, molded plastic materials are being used to a greater and greater extent and their electrical properties, especially arc resistance, have been greatly improved. Another significant development has been the availability of complicated porcelain moldings, porcelain having the characteristic that it will not char and become a conductor as molded plastics do. One general problem that has been partly solved, has been the search for a plastic material that does not carburize when used for arcing barriers. (63)

Built-in Motor Protection

Built-in thermal protection is becoming a feature in quite a number of makes of motors, especially in the fractional horsepower sizes. The aim is to put the thermal protection unit directly in the motor. Such thermal protection may be one of several forms. One method uses a bimetal disk. Some of these devices are automatic resetting and other require manual resetting. (64)

With improved permanent magnet materials now available, they are being used in switches to obtain a snap action. (65)

Capacity of Electronic Power Tubes

At present the maximum capacity of electronic power tubes in general use is about 10 k.w. at 220 v. Tubes of 15 k.w. capacity are being installed in some instances. The main drawback to the more general use of such tubes in the larger capacities is their cost.

Used for converting a.c. to d.c. the electronic converters are finding numerous applications for electro-plating equipment and where d.c. current is needed and the supply is a.c. Many of such tubes are also used in conjunction with photo-electric controls on automatic packaging and other machines. (66)

¶ Photo-electric controls are now made up as units. For example, photo-electric equipment for register control can be procured consisting of a light source with focusing light beam and optical system to focus the reflected light beam, all in the same unit together with the amplifier tubes. Another unit is the control panel containing the power tubes and contactors. (67)

Controls for Resistance Welders

Modern resistance welders use short timing ranging from ½ cycle to 10 cycles. Less heat is lost to the metal surrounding the weld and the metal that is raised to the fusion temperature does not extend to the surface of the work, thereby leaving a skin of entirely unaffected metal enveloping the weld. This is essential in welding some of the alloys, especially stainless steel.

By means of electronic welding controls the welding current can be controlled to start each time at exactly the same point on the voltage wave and stop at the zero point on the current wave after the passage of the number of cycles for which the time adjustment was set. This setting is readily changed by a dial adjustment. The

simplest and least expensive timing circuits is adjustable in one-cycle steps, which is fine enough for the most delicate applications of resistance welding. A more flexible control for adjustment of time in half-cycle steps is also available.

Another modification of electronic timing circuits applied to resistance welders permits the variation of the effective value of current supplied to the welds. (68)

Improved Arc Welders

Similarly, improved controls and generators have been developed for arc welding. This relates primarily to automatic voltage and current control to minimize variations when welding pieces of different thickness. (69)

Self-Synchronizing Motors

Refinements in the design of wound rotor synchronous motors have increased their field of use. Such motors are now obtainable to develop full torque at only 30 deg. armature rotation. In many applications two such motors will operate so closely in step that the variations are negligible. They are used on paper bag machines, insulation winders and similar applications to obtain synchronous rotation of different units, each unit being driven by its own motor. Gearing, shafting and bearings are thereby eliminated. (70)

¶ Improved electrical devices have again brought to the forefront the principle of Ward-Leonard control wherein the d.c. motor speeds are controlled by the generator voltage through adjustment of resistance in the generator field. Complete equipment consists of a motor driven d.c. generator with an adjustable resistance in the field for varying the voltage. Each motor that is to have independent speed control has its own generator. Applications include paper making machines, printing machines, textile machines and large power shovels. (71)

¶ One of the general aims in the design of motors has been to procure better insulation. The use of paper and cellophane insulation has resulted in less space being occupied by the insulation. In one type of this insulation the edges of the paper or cellophane are butted instead of being lapped, thus saving space. As compared to the conventional cotton-rubber insulation the space saving is considerable, thereby contributing to more compact motor design. (72)

¶ With respect to motor inclosures, closures have been designed to make open type motors splash proof. In the design of fan cooled motors, the designs have been developed to increase the efficiency of heat transfer to the outside air by improving the duct design. The result is better cooling and performance, especially in reversing motors. (73)

Capacitor Motors Improved

Capacitor motors are fast coming into greater use primarily because of the improvements in their design. These relate to the design of the condenser. Formerly this was contained in a bulky box fastened to the base or top of the motor. Now it is a compact unit integral with the motor. Most of these motors are capacitor start and running, a centrifugal switch changing the capacity from high to low when the motor has attained its running speed. (74)

¶ To avoid the dangers in taking out bearings to grease them, motor manufacturers now make the pressure fitting for greasing the bearing. Excess grease is spilled out through a duct. (75)

New Types of Cartridge Motors

Cartridge type or shaftless motors, wherein the stator is built as a frameless unit to be slipped into a bored housing on the machine, have been greatly improved. Formerly the "cartridge" was simply the stacked punchings and windings, being held tightly together with a drawn shell around them. In the new designs the punchings are stacked, pressed together, put in a mold and iron cast around them. The shell is then machined to much closer tolerance then was obtainable in the cartridges having the drawn shell. Thus a much better fit in the machine housing in which the cartridge is mounted is obtainable, and there is a tighter fit between laminations and shell. (76)

¶ Rolled shell type shaftless motors are now available, with a wider range of diameters and lengths in the various horsepower ratings. Another advancement is the increased range of flange type mountings for direct mounting applications. Further developments are motors having special electrical characteristics for specific applications, such as rapid reversing type motors that will reverse 60 times a minute or more, developing their full horsepower rating on each reversal, without over-heating. (77)

¶ One manufacturer reports a trend away from strictly standardized motors because of demand for special characteristics and mechanical details.

A repulsion start capacitor motor has been developed which employs repulsion starting to bring the motor up to speed, as with the repulsion start induction motor, instead of the split phase squirrel cage method, thus extending the use of the capacitor motor into the large size heavy duty starting field. (78)

Interchangeable Inclosures

A design has been announced featuring the ability to convert a normal open motor to the splash-proof or drip-proof type by the addition of an extra end head and inclosing bands over the frame. Also a normally open motor can be converted into a totally inclosed motor by replacing the standard end heads with the standard end heads of the totally inclosed motor, which in the case of the splash-proof motor increases the temperature rise from 40 to 50 deg., and for the totally inclosed motor the rating is reduced and the temperature rise increased to 55 deg. above ambient temperature. (79)

It is reported that motor buyers whose finished products require utmost reliability are turning from split-phase to capacitor motors, especially where frequent starting is required. Flange mountings are being used to a greater extent. (80)

¶ One manufacturer of small motors reports a change from babbitt to oil-impregnated composition bronze in sleeve bearings to eliminate freeze-up hazard in event of lubrication failure. Brass brush plugs are superceded by molded plastic plugs. (81)

Better Synchronizing Motors

Special light weight, high efficiency, low voltage, d.c. motors have been developed for operating the landing gear apparatus on airplanes. Also single phase motors operating at 7,500 r.p.m. have been developed for driving blowers, with special attention paid to the commutator and brushes. Another novel design is a synchronous motor capable of running at exact synchronous speed not only at no load or with a positive load applied, but also when operating with an overhauling load. (82)

¶ Close coupled oil burner motors can be obtained with special end bracket drilled and tapped to take any of the standard makes of oil pumps. The object is to relieve the oil burner manufacturer of the close machine work necessary to assure proper alignment, and also gives a neat appearance.

New Designs of Miniature Motors

Small, miniature size, geared head synchronous motors are receiving greater attention. They are obtainable in a great variety of mechanical and electrical features. One manufacturer makes miniature motors of the capacitor type, the capacitor measuring 1 in. in diameter and $2\frac{1}{2}$ in. long, supplied as a separate item. A great variety of gear reductions are available to give output speeds such as 1, 2 or 60, at which speeds the delivered torques are 75, 40, or 2 in.-oz. respectively. (83)

¶ Another make of self-starting synchronous type of motor draws 3 watts and delivers a torque of 5 in.-oz. at 1 r.p.m.

Also of the geared type, the output shaft speed may be 1 r.p.m. or $4\frac{1}{2}$ r.p.m. They are also being furnished with output shaft speeds of 1 r.p.h. and 1 r.p.d. for use on controls, instruments, time recording devices and similar purposes. (84)

Fractional Hp. Motors Redesigned

Another manufacturer of small motors has changed his entire line of fractional horsepower motors, motor generator sets and rotary converters. New end frame construction permits the use of one standard end frame for either open, drip-proof, splash proof, semi-inclosed and totally inclosed applications. Forced fan ventilation has been improved to give a greater flow of air, thereby reducing the motor temperature considerably below the NEMA specification. Other improvements being made include steel field rings, laminated pole construction, shifting brush holders for all sizes and uniform brush holder construction. These changes are being made to simplify construction, reduce manufacturing costs and improve the performance of the machines. (85)

¶ One manufacturer reports that the inclosed fan-cooled motor is becoming extremely popular for applications in metal working plants. The advantage of this type of motor is primarily that it excludes the fine metal dust from the internal windings. This same manufacturer designs the rotor as a complete unit, so that the rotor, rotor shafts and both end bearings can be removed as a unit. The end bearings are ball bearings mounted in a sealed cartridge and lubricated through an oil hole, thereby making it unnecessary to disassemble the bearings. (86)

More Motors Built-In

One motor manufacturer reports that there is a definite trend on the part of machine designers to make use of available space in the machine for the mounting of a built-in type of motor together with suitable controls. This company has developed flange type mounted motors and built-in type motors for such applications. (87)

¶ Improved impregnating compounds have been developed for insulating the windings of open motors. This compound is said to resist mild chemical fumes, dirt and abrasives and will not crack. (88)

Special Frames for Mounting Attachments

Because there is a marked tendency toward a demand for quiet operating motor on jobs where previously no special attention was paid to motor operating noises, one company has put more emphasis on quieting their general line of motors.

In their motors for furnace blowers, they have promoted the use of double shaft extension, slow

speed motors of the squirrel cage type with fans mounted on the motor shaft. This construction eliminates belts and pulleys and lends itself to automatic speed control.

This same company also reports a considerable demand for 2, 3 and 4 speed poly-phase motors for driving fans and blowers. Although these motors were designed specially, the manufacturer reports that the demand has been so great they expect to add them to their standard line. (89)

General Trends in Motor Design

In commenting on the general trends in developments in motors as reflected in the work of one manufacturer, he states:

"In general it seems that the outstanding development of the last year and a half is the increasing number of applications for industrial induction motors. Of course, the direct current motor has held the throne and even broadened its field a little within the limit where it is predominant; that is, in adjustable speed drives where delicate speed adjustment and accurate and complicated control is necessary.

"One way in which the use of squirrel-cage induction motors has been broadened is in the application of machines having special torque and current characteristics. Examples of these are high-torque high-slip motors for use on punch presses and other fly-wheel applications, high-torque motors for use on cranes in places where slip ring motors, or even direct current motors, have been used in the past, and an occasional torque motor for clamping or holding operations, or for maintaining tension in hoists, etc., which are built to stand stalled across the line for long periods and in some cases even to be run backwards occasionally. Multi-speed squirrel-cage and slip ring motors have come to be used more and more, particularly on conveyors, fans, blowers and machine tools. There are many uses for these motors on applications where direct current has been used in the past, but where a few definite speeds will do the job satisfactorily, and a wide continuous range of speed adjustment is not necessary.

"Inclosure of both the a.c and d.c. motors have seen many variations and adaptations recently for an assortment of applications. Occasional water-cooled motors are used for operation in high ambient temperatures where space is extremely cramped. Fan-cooled motors, both a.c. and d.c. are being used more and more for dusty or wet locations, and in some cases, certain manufacturers standardize their whole plants on fan-cooled motors in order that when motors are changed around, it will be impossible to get an open motor into a location where it will not be protected. Special mounting, built-in motors, and the like have been used more and more. These are applied very often to machine tools, both for appearance and compactness and are being used more and more for integral mounting with gear reducers and mechanical variable speed transmission.

"Mechanical changes in the electric motor have taken the form, usually, of mere refinements, small changes which make the machines easier to repair and to maintain. Samples of such small changes are better, roomier conduit boxes, covers for d.c. motors which are easier to remove and replace, covers for fan-cooled d.c. motors, having windows through which the commutation may be observed without removing the covers, better oil seals on sleeve bearing motors, and better greasing arrangement for ball bearing motors, the increasing use of cast aluminum rotors in squirrel cage motors, both to cut down maintenance and to improve the electrical characteristics of the motor, and built-in magnetic brake." (90)

Simplified Magnetic Clutches

New designs of magnetic clutches have aimed toward the elimination of wearing parts and greater compactness. By a simple rearrangement of parts, one manufacturer has appreciably decreased the length of his clutch in the various models and, perhaps of greater importance, has eliminated the major wearing parts. The same manufacturer has also developed a combination magnetic clutch brake for quick stopping and quick starting. (91)

¶ Indicative of the progress that has been made during the past year and a half in the design and application of magnetic clutches, at least two of the latest steel rolling mills built during that period are equipped with magnetic clutches for driving the screw-downs that adjust the roll spacing and pressure. The advantages of magnetic clutches for this purpose include their automatic slipping features, the simplicity of remote control, and the elimination of reach rods and control levers.

Better Built-In Instruments

Following the lead of machine tool designers in Germany, somewhat more attention is being given to supplying machines with built-in instruments such as ammeters, voltmeters and power factor meters. Thus there has been fostered considerable development in the design of such meters to make them suitable for the service. Quite a number of designs of such meters for flush mounting are now available. (92)

Flexible Automatic Timers

With the greater emphasis being placed on automatic operating features, improved timers have been made available. Such timers are flush mounted on the machine and can be manually set to automatically start the machine, change its speed and stop the machine, or follow through any other desired sequence of operating cycle. The time of operation for each period in the cycle is adjustable and a practically endless variety of cycles is obtainable. (93)

¶ Wiring accessories such as plugs, cords and connectors have been improved primarily with respect to the materials used. Soft rubber plugs have practically supplanted the older phenolic resin molded types. Plug prongs and terminals are anchored directly in the molded soft rubber plug. (94)

Improved MECHANICAL PARTS

William M. Rittase

IT WOULD not be practical to attempt a complete review of all the refinements that have been made in the design of mechanical parts and machine elements that are purchased as finished units. Therefore this review is confined to new developments that are more or less fundamental in character, indicate a trend or suggest new possibilities.

Chains and Chain Drives

Numerous developments in roller, silent and block chains for the transmission of power are reported. Stainless steel roller chains for corrosive conditions, temperature resistance and operations where non-magnetic properties are essential, and similarly, bronze chains of the "block" type have been made generally available.

In addition, there have been a great number of special designs of chains developed to take care of unusual requirements, such as bottle conveyor chains, counterweight chains and multiple strand chains. (95)

¶ An unusual development in power transmission chains is a $\frac{1}{8}$ in. pitch silent chain. This is claimed to be the smallest pitch silent chain ever manufactured. It has found quite a number of applications for drives in moving picture machines and similar applications. (96)

V-Belts and Sheaves

The principal improvements in V-belt drives has been in the materials used for the belt and details relative to its construction. Also, synthetic rubber belts for oil resistance are now obtainable. (97)

¶ Many new types of V-belt solid sheaves of improved construction have been developed, the principal features of these new sheaves being their light weight, greater strength and rigidity and improved appearance. Along with this the variety of standard sheaves has been increased to include a greater number of different diameters and different multiples of grooving. One manufacturer now has a standard line including 25 different diameters ranging from 3 in. up to 18 in. inclusive and having any number of grooves from 2 to 6 inclusive. Another feature of the design of these sheaves is that they are available with interchangeable and separable hubs which are carried in stock in bores ranging from $\frac{1}{2}$ in. up to the maximum, in $\frac{1}{16}$ in. increments. (98)

¶ Another company announces a new line of single groove semi-steel sheaves for V-belts. These sheaves are turned from solid semi-steel castings and are accurately balanced. (99)

¶ A companion line to that just mentioned is a line of pressed steel sheaves which are available in the same range of sizes at a slightly lower cost than the cast steel sheaves. (100)

Refinements in Gears

With reference to speed reducers, most of the manufacturers have re-rated their units to accord with the American Gear Manufacturers' Association practice, which was adopted about 18 months ago. Large size speed reducers use welded housings for special units, primarily because of the cost saving obtained where only a few of a given design are required. (101)

¶ One manufacturer of speed reducers reports that he now uses alloy steel gears and one piece alloy steel pinions on all of his units. High speed units all have oil coolers and a built-in pump for spraying the oil. (102)

Variable-Speed Transmissions

About a year ago a new type of variable-speed transmission was put on the market which consists of a motor and variable speed device all as one unit. Any make or type of motor can be furnished. Speed changes on the output shaft are obtained by varying the position of three hardened steel rollers which are in pressure contact with hardened steel races. These rollers are between

the input or driving race and the output or driven race. Means are provided for tilting the rollers, which changes the effective diameters at which the rollers operate on the races. The range of speed ratio varies from 6:1 to 10:1, depending on the size of the unit. (103)

¶ Another new type of variable speed transmission which has recently been placed on the market is also a self contained unit with the motor and reducer as one and using metallic rolling contact. Three taper rollers are kept in contact under pressure with a ring which rotates at a speed as determined by the motor speed. Pinions on the rollers mesh with an internal gear which drives the output shaft. Variations in speed are obtained by causing the ring to move along the taper rollers, thereby changing the speed ratio between the tapered rollers and the ring.

The motor is either built-in or connected by means of a flexible coupling in which case the motor and unit are mounted on a common bed plate. Or the unit may be driven from a line shaft or other source of power. (104)

Variable-Speed Belt Transmissions

A new design of variable-speed control unit put on the market during 1936 embodies a combination of variable speed V-belt motor pulley and a variable-speed transmission. This transmission is obtainable in sizes, ranging from $\frac{1}{4}$ to 10 hp. and covering speed variations ranging from 2 to 1, to 6 to 1. For extremely low output speeds, there is incorporated a helical gear train. (105)

¶ For such applications as synchronizing different machines or different sections of the same machine, or for the maintenance of constant temperature, constant tension, uniform peripheral and winding speeds, or for the maintenance of uniform pressure, weight, liquid level, and other variable elements, there has been made available automatically controlled variable speed belt transmissions wherein the control is by means of hydraulic units, electrical units or mechanical means. Or the automatic control may be secured by a differential auxilliary that operates on the same principle as the differential used in the rear axle of automobiles. Two shafts of the differential are driven by the shafts to be held in synchronous speed. Lack of synchronism causes the otherwise stationary third shaft to rotate, which rotation adjusts the variable transmission so as to restore synchronism.

Whether the automatic control be hydraulic, electrical, or mechanical, the principle is the same. Speed control is accomplished by connecting the actuating lever of the automatically controlled transmission to some member on the machine being driven. This member may be a floating roll, a governor, pressure regulator, float, scale beam, cam or any other moving element that is related to the speed of the machine. (106)

New Flat Rubber Belts

A new type of flat rubber belt recently developed is claimed to compensate the stresses in each ply when the belt is bent round the pulley so that each ply bears its own share of load. This is claimed to eliminate the high stresses in the outer plies, as in conventional belting. Another development announced by this company is a special surface friction that enables the belt to be run at exceptionally low total tension. (107)

¶ A new type of conveyor belt features a special rough surface on the rubber cover for handling packages, cartons and boxes on inclines up to 30 deg. This special cover surface consists of a series of small rubber fingers, of which there are 3,000 in every square foot of belt. (108)

¶ By means of a special fabric construction which permits a greater penetration of the rubber, there has been obtained a belt which is essentially homogeneous in that the covers and the fabric plies become an inseparable mass. With this construction the separation of covers and plies is practically eliminated, the belt troughs better, and belt stretch has been greatly reduced. (109)

New Universal Joint

An unusual design of universal joint has just been announced. The load carrying parts are forged steel. Zinc is die-cast around portions of the forgings and ball races are imbedded in the zinc. The universal action is obtained by balls bearing on races, so arranged that the angular velocity of the driven member is constant for any constant angular velocity of the driving member. (110)

¶ Much attention has been given to over-running clutches or couplings. Improvements during the past few years have been mainly to obtain greater simplicity of construction and improved operation. They are designed so that they can be adjusted to take up wear. Not only are these used for clutches and couplings but also as ratchets. (111)

¶ One manufacturer of disk clutches has faced the clutch fingers with Stellite in order to minimize the wear at this point. Also there have been numerous improvements in the design of the clutch throwout bearings, primarily to develop a design of bearing that will not require lubrication. (112)

¶ With reference to magnetic type clutches, these have been discussed in the electrical section of this review. Main improvements are in the elimination of unnecessary parts, better provisions for cooling in order to increase the clutch capacity and coils that can be replaced in a minimum of time. Novel methods have been developed for adjusting the driving surfaces for wear. (113)

New Anti-Friction Bearings

During the past year one bearing manufacturer has developed a new "cartridge" type bearing. This is of the double row width, has a larger grease volume than the conventional self-sealed bearings, and has specially designed removable seals.

For use in the aircraft industry, there have been quite a number of new designs of excep-

tionally light type bearings. In one such design, the bearing is of the full type without retainer and is completely inclosed in metal shields and has cadmium plating on all exposed surfaces, as required by army and navy specifications. (114)

¶ To make possible quicker and simpler application of the bearing without tools of any kind and to assure the user that the bearing is positively locked to the shaft, there has been designed a bearing wherein an eccentric groove is machined into the bore of the extended inner race. Fitted in the eccentric groove is a piece of spring steel which acts as a "shoe." When this shoe is in the deepest part of the eccentric groove, the bearing may be readily slipped on the shaft. By holding the inner race of the bearing while the shaft turns in the direction of operation, the knurled ends of the shoe grip the shaft, causing the shoe to wedge in the shallow part of the eccentric groove. This securely locks the bearing on the shaft. (115)

¶ In a new design of radial type bearing, the outside diameter is only 0.3125 in. and the bore is only 0.073 in. The bearing is made of 52,100 S.A.E. chrome steel and has 10 balls $\frac{1}{16}$ in. in diameter, made of high carbon chrome alloy. (116)

¶ A new clutch throwout ball bearing is reported to have run continuously for 1,464 hours with a total of 2,050,421 declutchings. Outside of the original charge of lubricant, no further grease was added during the run. (117)

¶ Other developments include a type of ball bearing for high speed precision machine tool spindle mounting, a rubber mounted ball bearing pillow block designed particularly for household heating and air-conditioning equipment, and improved straight roller or needle bearings for diesel engines, stationary gas engines and air compressors. (118)

Better Lubricating Devices

New types and designs of lubricating devices are more a matter of refinement rather than completely new types of devices. Thus one manufacturer provides "unbreakable bottles" in their constant level oilers. These sight-feed oiler bottles are made of plastic material, practically as transparent as glass but cannot be broken. (119)

¶ Other improvements in design include the greater use of die castings for the bodies of lubricating devices and oil resistant synthetic rubber where required. (120)

¶ A number of new types of oil seals or closures have been put on the market in the past year. These use leather, felt or special compositions for the sealing element. (121)

Developments in Hydraulic Controls

Whereas hydraulic controls were formerly designed special, during the past several years there has been a great deal of development work in the design of control units and panels that have more general application.

As an example, there has just been placed on the market a new feed control panel which is applicable to drilling and reaming, boring, turning, milling and similar machine tools. This control panel is adaptable to a wide variety of cycle requirements. It will provide any cycle sequence such as rapid advance, adjustable coarse feed, adjustable fine feed, and rapid return.

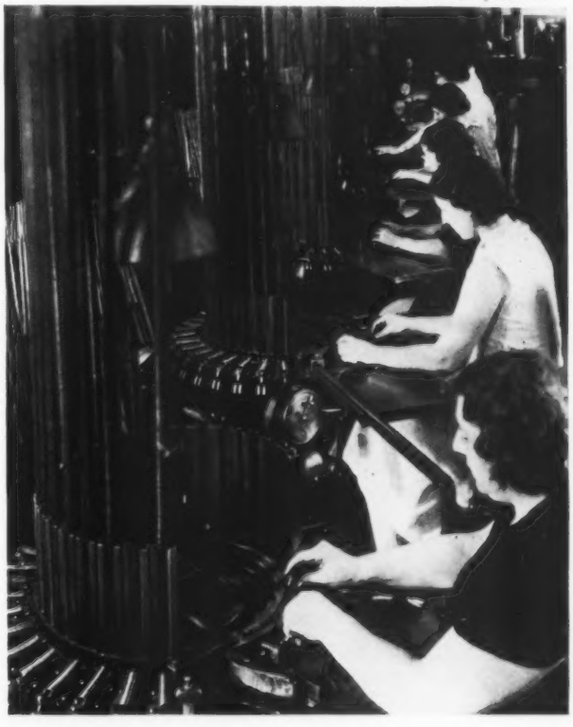
The main internal control valve in this panel is actuated either manually by throwing a lever, mechanically by trip cams on the moving platen contacting the plunger roller, or electrically by energizing solenoids separately.

In spite of the many complicated operating cycles that are obtainable, the unit itself contains only two moving parts,—namely, the main control valve and the feed compensator. The panel can be installed or removed merely by taking out readily accessible socket head screws. There are no pipe fittings to remove as the connection between the control panel and the hydraulic system is effected through gasketed surface. (122)

¶ One hydraulic pump manufacturer has recently placed on the market a complete line of variable and constant displacement piston type pumps in sizes ranging from 2 to 150 hp. and a companion line of variable speed hydraulic transmissions together with remote controls. Another has added a complete line of fluid motors. (123)

¶ Improved designs of a flange type spiral gear pump with ball bearings; a new combination unit consisting of a spiral gear pump for hydraulic operation and a centrifugal pump for coolant; and a design of hydraulic type spiral gear pump with special mountings for use on road construction machinery have been announced by another manufacturer. (124)

Baldwin-Duckworth Chain Corporation



¶ Plunger type pumps for variable displacements made by one manufacturer have been simplified by restricting the return stroke of the piston in order to obtain variable displacements. This improvement is claimed to allow a uniform rate of change of displacement when shifting from one displacement to another and then again returning to the original displacement. This manufacturer also reports that the main improvement in his gear type pumps and valves has been with reference to means for mounting so that piping connections will be eliminated. (125)

¶ The widespread use of hydraulic control has made necessary the development of special hose. One such special pliable and flexible hose consists of a specially compounded oil-resisting tube; one, two or three braids of fine but exceedingly strong wire, with a layer of braided cotton between the wire and the cover. All braids of wire and cotton are imbedded in rubber.

The hose is available in sizes ranging from $\frac{3}{8}$ in. to $1\frac{1}{4}$ in. A permanent pressed type of coupling is recommended and supplied by the manufacturer but construction permits use of any of the standard detachable types, if desired.

In addition to this standard line, there is available hydraulic hose for special services which call for extremely high working pressures. During the past year hose has been constructed which is capable of withstanding pressures up to 20,000 lb. per sq.in. (126)

High-Pressure Air Hose

Heretofore, it has been impossible to compromise on air hose construction. If the user demanded a hose possessing high flexibility and strong cover adhesion, he had to choose one of braided construction. On the other hand, if his requirements called for a firm hose with high resistance to expansion and internal heat, he had but one choice—wrapped construction. There is now available a hose that is suitable for all types of high-pressure air service which incorporates the chief advantages of both the wrapped and braided construction and is highly resistant to oil and heat. (127)

¶ The trend in the spring industry has been more and more toward the refinement of specifications to effect a lesser degree of variation in the physical dimensions of the spring and continual progress is being made in the direction of working with materials that have high fatigue resistance. One manufacturer reports that during the last eighteen months they have done much development work with reference to the use of Inconel and beryllium-copper for springs. They state as follows:

"Two recent developments in metals, Inconel and beryllium-copper, offer interesting possibilities to users of springs. Inconel, with a modulus of elasticity so close to that of steel that it can be readily substituted without change of dimensions, offers resilience in temperatures up to 900 deg. F. with high resistance to corrosive attack at both high and low temperatures.

"Beryllium-copper, with a modulus of elasticity higher than that of phosphor bronze can be readily substituted for the latter. It offers greater resistance to corrosive attack. For electrical applications, it offers higher conductance values than phosphor bronze. These modulus and conductance factors therefore permit the use of smaller size wires to accomplish the same results. In addition, the metal can be heat-treated to produce exactly the desired physical characteristics required for sensitive calibrated instruments. Of specially great importance is the fact that age hardening or season cracking is avoided. This tends to increase the life of the springs." (128)

¶ Another spring manufacturer reports: "While not new, during the past eighteen months there seems to have been an increasing interest in stainless steel and beryllium alloys. We are doing much development work on these for use as spring materials." (129)

Better Screw Fastenings

One significant change that has taken place rapidly is the trend from carbon steels to alloy steels and the various stainless steel grades for all types of screws and fastenings. So great is the demand for the stainless steel grade of 18-8 that this manufacturer is now carrying a complete stock of bolts, nuts, cap screws and washers in this material. (130)

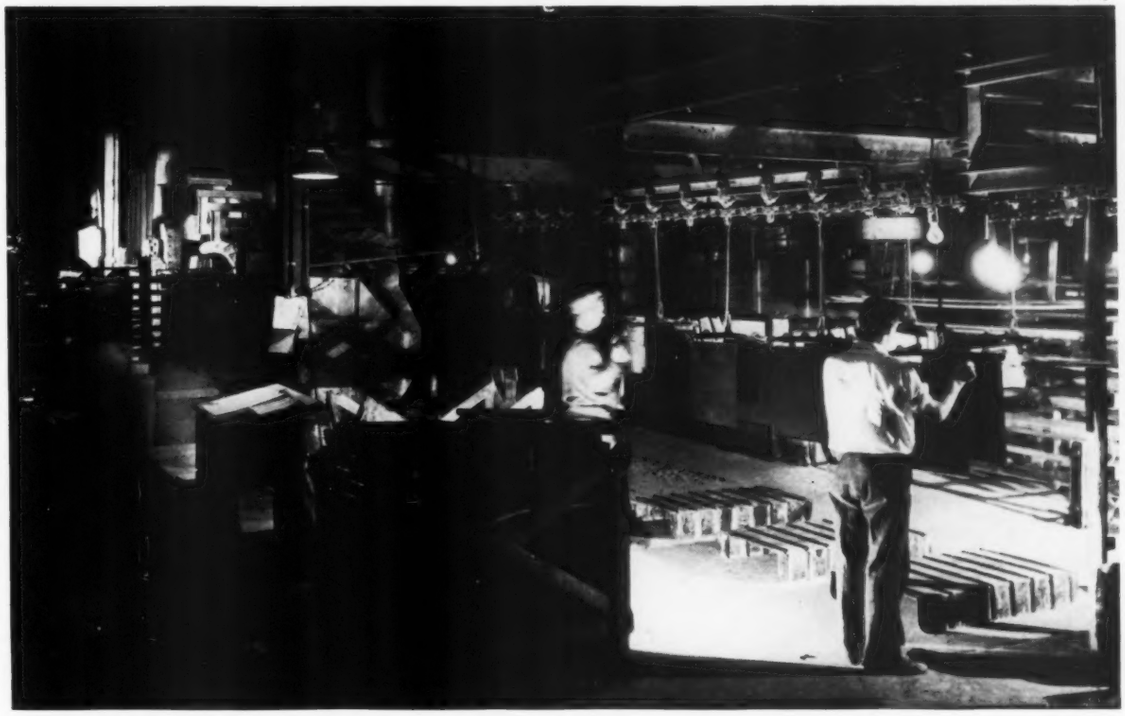
¶ Another development of the past two years has been that of recessed heads, self-centering screws and bolts. These are now available in a complete line of cap screws, machine screws, bolts and case hardened sheet metal screws. The head of the screw or bolt is recessed in the shape of a cross into which fits the ends of a special screw driver. The recess is shaped so that the screw can be held freely in the end of the screw driver, much in the same manner as a hollow head screw can be held by its wrench. (131)

¶ Another type of fastening that has been developed over the past few years is a "structural rib bolt." The feature of this bolt is that the shank is splined to form a number of straight ribs. The bolt is driven into a slightly undersized hole. Thus the bolt cannot turn in the hole, thereby permitting the nut to be drawn up tightly. (132)

¶ A new type of expansion plug for holes in castings and machine parts is now available. These plugs are simply concave disks stamped from metal and are available in a wide range of sizes. They are inserted in the counter-bore of a hole and fastened by pounding the convex face flat. This expands the plug tightly against the sides of the hole to produce a leak-proof seal. They eliminate the necessity of pipe plugs and threading operations, are speedy to assemble, make a perfect seal and give a finished appearance. These expansion plugs, formerly furnished in steel only, are now available in stainless steel, brass, aluminum, or copper. They are finished by nickel plating, cadmium plating, chromium plating, brass plating and sherardizing. (133)

Better FINISHES and PROTECTIONS

Porcelain Enamel & Mfg. Company



IMPROVEMENTS in finishes are of a nature that is not apparent from a casual observation or even a close visual inspection. During the past year and a half, much has been done in the development of more flexible lacquers that do not peel nor chip, in new methods of electro-plating finishes possessing greater corrosion resistance, finishes suitable for high temperatures and improved porcelain enamels.

Heretofore it has been practically impossible to make paint coatings stick to zinc or cadmium surfaces. There have now been developed a number of chemical processes for overcoming this difficulty. These chemical processes are extremely simple and it is merely necessary to clean the parts and immerse them in the chemical solution or spray it on, then allow them to dry and apply the paint or lacquer. (134)

¶ During the past year there has also been developed an electrolytic process wherein an alternating current coats the steel with a dense insoluble coating. It is claimed that steel parts thus treated will resist rust for long periods of time, even if unpainted. The process has been used in the automotive industry for parts such as lamp bodies. (135)

¶ For iron or steel parts, there has been developed a chemical oxidizing process that gives the steel a uniform jet black color, simply by immersing the part in a chemical solution kept at about 270 deg. F. Because the finish is the result of a chemical reaction, it is a part of the parent metal and cannot chip, scale, peel nor discolor. Also for this reason the sheets can be stamped, rolled or formed without injury to the finish. (136)

¶ A recent development is a finish that is claimed to be capable of resisting exceptionally high temperatures without discoloring. After chemical rust proofing the part, a coat of a new heat resisting stove enamel is sprayed on. It is stated that this finish has been tested in a temperature of 1300 deg. F. overnight and remained in good condition. It has been applied on the polished top of kitchen ranges. (137)

¶ Chemical processes are available for preparing aluminum and aluminum alloys for painting and extensive work has been done in developing new chemicals for cleaning parts. (138)

¶ With reference to lacquers, the principal aim has been to obtain coatings possessing extreme flexibility. There are now obtainable steel strips that

are finished coated and can be stamped and formed in any desired manner without injury to the coating. Even deep drawings such as threaded bottle caps can be made from such pre-finished strip. (139)

¶ The field of pre-finished sheets and strips has been greatly extended also with respect to electro-plated strips. These developments have all been in the direction of making the strip capable of being formed into relatively complicated shapes without injury to the finish. (140)

¶ An enamel has been made available that gives a pattern of uniformly small wrinkles. It is available in a large variety of colors. (141)

¶ One of the leading manufacturers of varnishes reports the development of a water-white clear gloss lacquer which adheres well to cold drawn wire that has been cadmium plated. The manufacturer points out that the lacquer will not adhere well to the cadmium if there are any traces of cyanide on the surface of the wire. (142)

¶ Another recently developed baked enamel finish has the property of being resistant to the action of chromium and gold plating solutions. By the use of this enamel, it is now possible to completely enamel the part, high light the raised surfaces and then electroplate them. One unusual feature of this new enamel is that even if a number of coatings are applied, only one baking is necessary. The finish is obtainable in all colors. (143)

¶ In electroplating, the main progress has been in the development of better plating equipment and brightening agents. Perhaps the latest of the bright plating processes is the bright zinc plating which was brought out about a year ago. Even within this short space of time, this process has been greatly improved. (144)

Porcelain Enamel & Mfg. Company

¶ A new electroplating process recently announced makes possible the electro deposition of tungsten in combination with other metals. By this process tungsten-nickel, tungsten-cobalt, tungsten-iron, tungsten-molybdenum, tungsten-tantalum, tungsten-columbium can be deposited. Some of the ternary combinations are tungsten-nickel-cobalt, and tungsten-nickel-iron. Also quaternary combinations such as tungsten-nickel-cobalt-iron can be plated.

It is claimed that by this process it is possible to utilize many of the important and highly desirable metals in combinations which heretofore have been unattainable.

It is stated that the standard nickel plating equipment is adaptable for this process merely by using special types of anodes, metallic salts and essential re-agents. (145)

¶ Many improvements have been made in vitreous porcelain enamel finishes. Black edge frits have now been developed to the point where satisfactory edging can be obtained by spraying the black enamel directly over the ground coat before the latter is fired. In the last year the use of this type of enamel has become rather general and has resulted in lowering costs because of the elimination of an additional firing.

There has also been developed improved white enamel for cast iron which compares favorably with white sheet iron enamels in color, brilliance and results.

What are known as "clear over-glaze" enamels have been receiving much recognition during the last year. It is now possible to adhere to regular enameling practices and obtain an acid-resisting surface by giving a light coat of acid-resisting glaze over the finished article.

Among the new types of porcelain enamels recently developed, there is now available a highly opaque porcelain enamel which permits the application of thinner coats. The advantage of this lies in the fact that the same degree of coverage can now be obtained with much thinner coatings than with the older types of enamels, these thinner coatings resulting in a materially increased life of the finish.

With reference to color in porcelain enamel finishes, much progress has been made not only in the variety of colors themselves, but the ability of the industry to develop or match practically any color or shade. With the new frits of higher covering power tendencies toward variations in color have been brought under control. Further, by means of numerous variations from the usual enameling practice, there has been developed in the past few years finishes known as stippled, marbleized, grain, mother-of-pearl and others.

In addition to color varieties, one of the most important developments has been that of acid-resisting enamels.

New undercoatings or ground coats have been developed which permit much lower temperatures in fusing the coat to its metal base. This has done much to eliminate warpage during the firing and has also made it possible to apply porcelain enamel to difficult shapes which heretofore might have created quite a problem. (146)